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**THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.**

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The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk *(Telephone* 339*)*

## Forthcoming Events.

APRIL 9.

*Sheffield Metallurgical Association*:—Social evening and presentation of Sorby Prize for 1928.

APRIL 11.

*Institute of Metals (London Local Section)*:—Annual general meeting at 83, Pall Mall, S.W.1. Discussion on "Hardness Testing," opened by Dr. Hankins.

APRIL 17.

*Institute of Metals (Swansea Local Section)*:—Annual general meeting at Swansea.

**Institute of British Foundrymen.**

APRIL 6.

*Lancashire Branch*:—Ordinary meeting at Manchester. "Foundry Organisation," Paper by J. Yates.

APRIL 9.

*Lancashire Branch (Burnley Section)*:—Annual general meeting at Burnley. Discussion opened by J. Jackson.

APRIL 11.

*London Branch*:—Annual general meeting at Engineers' Club.

## On Sheer Merit.

The February issue of the "Bulletin de l'Association Technique de Fonderie," which only arrived here on March 25, is almost entirely devoted to the newer methods for testing cast iron, and at the outset we must protest against an unfair and unjustified remark which appears in the middle of the second column of page 43. In abstracting a leader—"A Strange Attitude"—which we wrote on May 21, 1925, the abstractor finds it necessary to remark that the editorial in question *appears to be inspired by Mr. John Shaw*. It should be distinctly understood that we were not a member of the I.B.F. Test Bar Committee, and our only connection with it was that the Committee did us the honour of asking us to edit, before final publication, the draft specification for testing cast iron. We are quite sure that Mr. Shaw would confirm our statement that he did not inspire our remarks. At this period (1925) when we presented this leader, we sensed (because of a proposed Pan-American Engineering Standards Conference in Peru) an effort to internationalise the American 1.2 in. arbitration bar. Now conditions have changed, and there has grown up in America a large volume of opinion definitely in favour of the new British system of providing bars to be tested for transverse and tensile strength, but of three sizes so as to take cognisance of the thermal history of the average section of the casting to be inspected. Simultaneously, much propaganda has been emanating from the Continent in favour of the Frémont and shear tests. That the French are taking a definite stand on these tests is shown by the only block of black type in their February bulletin. Translated, their committee makes the following appeal:—

"Our conclusion is an appeal to all our colleagues, the French founders, to interest themselves in these methods, which first saw light in France and which (quite imperfect as they may still be) are solely capable of providing information as to the actual castings.

"We ask them to substitute them for the old tensile tests of which the researches of Mr. Portevin has demonstrated their inadequacy, and for test pieces cast separately it has been definitely proved that they cannot represent the castings, as their rate of cooling is entirely different.

"We also ask those of our colleagues who daily carry out tests to keep the Committee *au fait* with the results obtained, any difficulties encountered, and also of any improvements that perhaps can be incorporated.

"This will materially help in the discovery of a means of control of a definitely efficient and unified character."

It seems rather futile to boost a scientific proposition such as a method of testing on the grounds of patriotism—surely science knows no boundaries. Inherently, a mistake is being made by assuming that the thermal history of casting is the same in thick and thin sections. One of the claims of the Perlit process is a unification of structure throughout a casting. What practical founder has not seen white iron "flashes" attached to a grey-iron casting? Again, what founder could not, if he was evilly disposed, modify the thermal history of any portion of a casting from which he wanted to trepan a small test piece? Auto-annealing apart, trepanned test pieces mechanically tested give no more nor less useful information than a separately-cast test piece of similar section to the casting teemed under adequately imitated conditions. Commercial considerations obviously impose a limit, and the three bars originated by the I.B.F. appeal to us as being, in the light of the present state of the art, adequate for providing the engineer with pertinent knowledge as to the quality of the metal in the casting under test.

Finally, we commend the attention of our readers, both British and foreign, to the test results carried out and presented on another page of this issue by Mr. W. Jolley, which outline the serious nature of the difficulties evidently envisaged and stressed in the third paragraph of the French Committee's appeal. We feel that this and other information which has come to our knowledge will relegate tests taken from cast-iron castings by means of trepanning small test pieces to their proper place—that is, the research laboratories—where they can remain until such time as the practical founder can ensure a homogeneous metal in every diverse section of a casting and the engineer provide precision tools for excavating and testing trepanned test pieces.

## The Balfour Report—II.

The early sections of the report can be dealt with quite briefly. They deal with the question of access to overseas markets and access to the means of production, notably capital, power, raw materials and transport. With regard to the first-mentioned point, Great Britain enjoys access to practically all foreign markets and has the benefit of "most-favoured nation" treatment. Where tariffs are imposed British goods generally go in at the lowest rate of duty. The report quotes the prior report of the Geneva Economic Conference on the difficulties created by tariffs, and emphasises the fact that it is to

British interests to negotiate and participate in international agreements and conventions designed to ensure other countries conforming to the basic liberal principles underlying British commercial and economic policy.

In Empire trade the report points out that the Dominions have complete autonomy in the construction of tariffs, but that British goods are admitted on specially favourable terms. The Committee does not pretend that we can give a direct preference to Empire goods in our markets which will compensate for our preferences in Empire markets, and is strongly opposed to any export tariff which would restrict Empire supplies, like rubber, wool, jute and so on, entering foreign markets.

Coming now to the access to means of production, it is found that there is no artificial obstacle to the import of the raw materials we require, either in the way of customs duties or shipping. With regard to capital, the Committee would not attempt to interfere with the export of capital, which in itself is a valuable cause of export trade. It is found that the bank machinery for supplying financial assistance is adequate and suitable, and the bank amalgamations have not produced a monopoly or impaired service. The vexed question of whether the banks do help industry enough is discussed. Banks have been criticised from two opposing points of view. Some say they do not aid industry enough and others say they keep weak undertakings alive too long by their unwise financial aid. The report discusses the return of the gold standard, admits the difficulties it brought about, but argues that nobody now would wish to depart from it.

In dealing with transport, the whole question of ocean shipping, railways and canals is discussed, and the impression is given that the Committee feels much more satisfied with the condition of British shipping than with British railways. The remaining "means of production" is power. It is shown that, so far as machinery is concerned, British industry is as well off as any, because it has not only an efficient home engineering industry, but it has access to foreign machinery without import restrictions. So far as power itself is concerned, the supply is governed by the supply and utilisation of fuel, and the organisation of electric power supply. The former is, of course, having a good deal of attention in the coal trade and the latter is in the care of the Electricity Commissioners.

We can, therefore, deal later with the conditions of employment in relation to competitive power, including wages and hours, industrial peace, unemployment and welfare; and, in a final section, with other factors in competitive efficiency, such as standardisation, research, education and combinations.

## Aluminium Alloy Cranes.

The Alliance Machine Company, Alliance, Ohio, America, has received an order from the Aluminum Company of America for a 10-ton travelling shop crane, the main girders of which will be constructed from strong aluminium alloy. This use of aluminium will materially reduce the wheel load on the building, and, it is expected, will also reduce operating costs.

Upon completion the aluminium crane will be installed in the new structural shape mill at the Aluminum Company's Massena works. At the same time it is planned to install a duplicate of this crane built of steel in the blooming mill at Massena so that direct comparisons of operating expenses can be made.

It is interesting to note that British India led the world as exporters of pig-iron to the United States of America by supplying last January 7,315 tons. Great Britain was second with 5,250 tons, out of a total importation of 16,108.

## Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

### Pulverised Fuel for Cupolas.

*To the Editor of* The Foundry Trade Journal.

Sir,—In your issue of March 21, 1929, you give a very condensed report of Papers on "Powdered Fuel" read before various institutes. In one of them Mr. Roosen mentions a firm in Scotland which has been working a cupola with powdered fuel, and I would be obliged if he would give the name of this firm and tell how they work it.

Hoping that Mr. Roosen, or yourself, or some of your readers will be able to supply the information, I am, Sir,—Yours, etc.,

"Boz."

## Catalogues Received.

### Plastic Refractory.

Messrs. Thomas E. Gray & Company, Limited, of 119, Holborn, London, W.C.1, have prepared a series of seven mailing cards, each carrying a definite and distinct message. The cards are all of different tints and printed in two colours. If the object has been to prevent the dilution of a sales message by excluding material of only remote interest to any concern, then this laudable end has been accomplished. But if it is proposed to send each card in turn to every potential buyer, then waste will be incurred. For instance, No. 4, intended for the rolling mills, would not interest 85 per cent. of the iron foundries. Intelligently distributed, they constitute an excellent series.

### Nickel Cast Iron.

This is the title of the latest publication, B 4, issued by the Bureau of Information on Nickel, Limited, of 2, Metal Exchange Buildings, London, E.C.3, and is an account of laboratory foundry researches carried out by Professor Hanson, of Birmingham University, and Dr. Everest. The pamphlet illustrates and summarises in an interesting and convincing manner the results so far achieved. The whole question of nickel in cast iron has now reached a critical stage. The experimental work and practical trials in the foundry are shown to exhibit real promise, and, apparently, it now only needs such results as life tests on automobile and lorry cylinders to establish (or at least expand) an alloy cast-iron section of the foundry industry.

## Publication Received.

### Nickel.

The Bureau of Information on Nickel, Limited, 2, Metal Exchange Buildings, London, E.C.3, thought fit to issue, in connection with their stand at the British Industries Fair, a pamphlet explaining in detail the activities of the Bureau. That this was a wise step is shown by the reviewer, who until its receipt thought he was completely cognisant of its work. A perusal, however, of this brochure indicated to him that service of an extremely wide character is available. It acts in a consulting capacity; it publishes condensed information for the busy man; it has a lending library and practically assists those who are carrying out tests incorporating the use of nickel. The whole of these services are given quite free of charge. Having set out the above, it seems unnecessary to state this, and all other of their publications, can be had by our readers on application.

## Random Shots.

In the spring a young man's fancy oft-times finishes down the course, as Jack Buchanan says, but you will have gathered something of my undoubted ability as a prophet by my suggestion as to the Cup finalists at Wembley! I often wonder what must be the feelings of those gentlemen who make a living, in the newspapers, by giving the winners. The infrequency of their particular fancies winning is shown by the frantic way in which they advertise a success. Of course, those who do it by post can, by judiciously mixing their tips, always please one section of their clientele. But if my tip had failed to get home, I should have spent next day going hot and cold all over.

* * *

I feel in some obscure way as if my perspicacity had been rewarded, for by a most extraordinary coincidence I drew two winners in a sweep on the Lincoln. My own ticket gave the winner and one taken out by a friend on my behalf, a fact unknown to me until after the race, gave the horse coming third. Hence a little pardonable spring enthusiasm, for the event seemed to lighten the gloom of a rather dull week.

* * *

The continued success of Cambridge will doubtless set all the pens wagging as to why the pronounced superiority of this University. They also won the sports, and undoubtedly the difference is very marked. The advantage enjoyed by Oxford in having Rhodes scholars does not appear to avail her much, in spite of the fact that these men combine brain with brawn. Dare we suggest that the type of training which Cambridge excels in giving, a modern, mathematical or scientific training, appeals to modern youth rather more than the classical and humanistic studies for which Oxford is the more famous?

* * *

Did you hear the story of the Aberdonian who went to London and had the misfortune to drop a shilling down a grating in the Strand? He immediately reported the loss to Scotland Yard, and next day he was surprised and gratified to see that during the night an army of men had settled in and were busy removing chunks from the road with the aid of pneumatic drills. He went back home satisfied, and said to his friends, "Ye ken, they're mighty carefu' in London."

* * *

There was a revival of interest some time ago in the limerick, but few new efforts equal the really classic examples. Here are two:—

There was a faith-healer of Deal,
Who said, "Although pain isn't real,
If I sit on a pin
And it punctures my skin,
I dislike what I fancy I feel."

There was a young fellow called Starky,
Who had an affair with a darky:
The result of his sins
Was quadruplets, not twins;
One black and one white, and two khaki.

* * *

Charlot ran a number of competitions for limericks, epigrams and sayings in connection with his broadcast entertainments, and the level of merit does not strike one as very high. Here was a toast to a flapper:—

Here's to the flapper, so very erratic:
As a bungalow she's been defined:
All paint at the front,
And shingled behind,
And nothing at all in the attic.

Marksman.

# "The Shear Test" not a Satisfactory Test for Cast Iron.

By W. Jolley.

Since the formation of the British Standard Specification for General Grey Iron Castings, Grades "A" and "C," arranged by the British Engineering Standards Association, the writer, who was a member of the Standards Committee represented by the Institute of British Foundrymen and British Cast Iron Research Association, has carried out a series of tests to see if the specified tests are the best methods to represent the differences encountered in cast iron. In looking through recent literature on the methods of testing cast iron, the predominant feature appears to be the suggestion for the substitution of a shear for the tensile test.

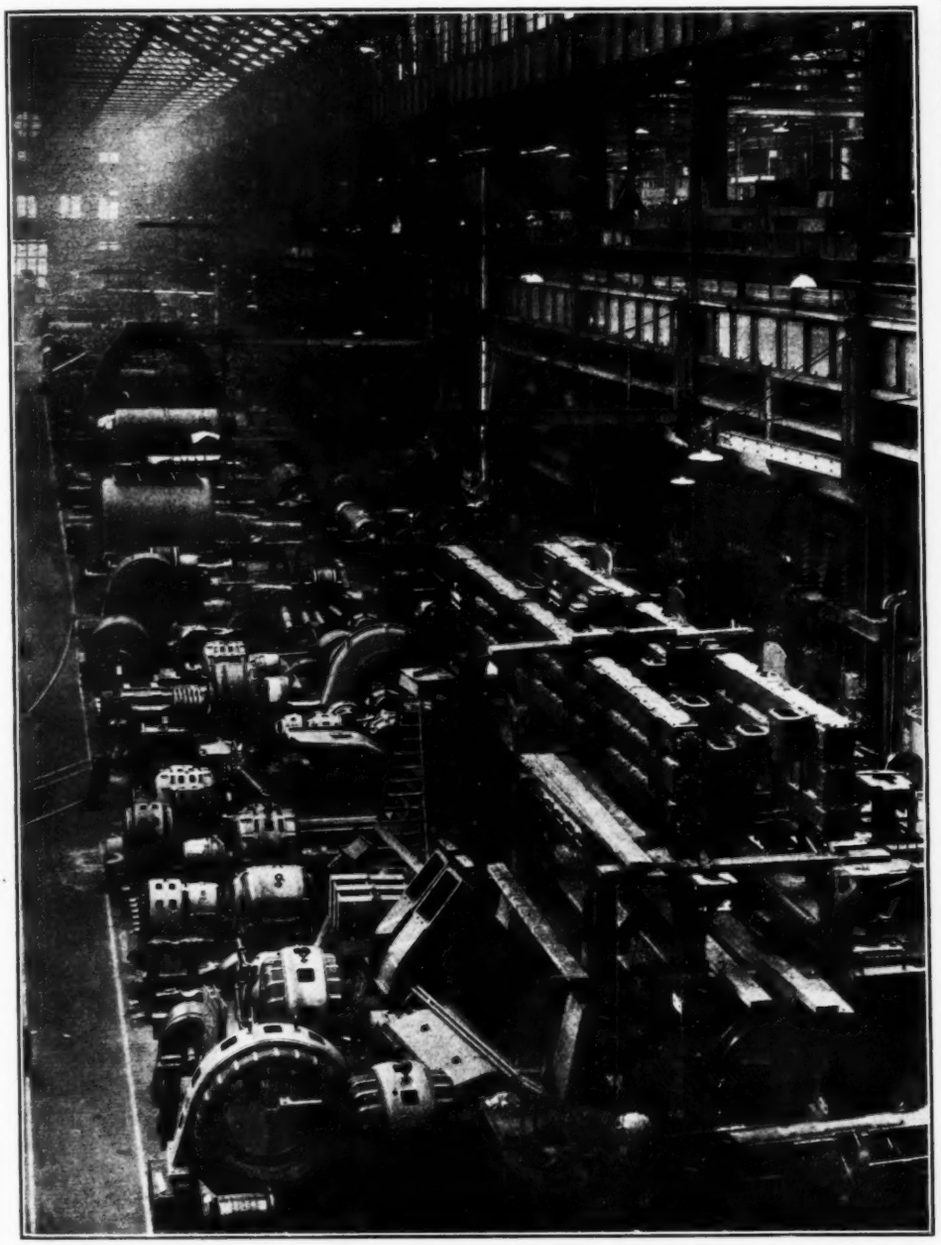

Fig. 1 shows castings, the majority of which are subjected to tensile testing to satisfy the British and foreign Inspecting Authorities.

In practically every case, the advocates of these changes state that the tensile test on cast iron is unreliable, as any deviation from a straight pull gives erroneously low-tensile results and should be abandoned, as the metal cannot suitably be classified by means of it. The results of these low-tensile tests are, therefore, against the metal and not in its favour. Does this not then point to the fact that it is for the foundryman to adopt loading methods for his tensile tests from which he can obtain reliable results?

In carrying out a series of tests with duplicate and triplicate tensile test bars, the writer has never found any wide discrepancy in the results between bars (1) truly axially loaded, (2) ordinary ball tackle, and (3) slight setting from a straight pull. The point of fracture on the tensile test-piece does not appear to make any material difference.

Mr. J. W. Bolton[1] appears to have had similar results, and he states that carefully conducted tensile tests made on reasonably aligned equipment will give useful results, and the wider use of tensile tests by foundries deserves encouragement. Also the results of tensile tests, using Robertson shackles and regular ball joint equipment, did not show any wide variation.

From the above and other investigators' work on this subject, it appears that the tensile test, if correctly carried out, can be made a satisfactory test, also it is a test in conjunction with the transverse test that is specified by a large number of engineers who derive a large and comparative amount of information from it. It is, therefore, necessary for the foundryman to meet this test and not to offer the engineer a substitute, because the test he specifies cannot be regularly obtained unless carefully-controlled methods are adopted. This is what the engineers desire—carefully-controlled methods in the production of the work they design.

In considering the shear-test methods, the first consideration is the method for obtaining the test specimen. This is obtained by trepanning a 0.22-in. dia. piece from any regular part of the casting. The writer has tried various tools to obtain both 0.22-in. dia. test-pieces and 0.5 in. dia., but has not been successful in obtaining a perfectly round bar; variations between 0.002 to 0.007 in. have been found to exist in one bar, also the surface is very irregular and not a smooth finish such as is given by the machined test-piece.

Elliott[2] and others found similar difficulty when investigating this method of testing, and it is the writer's opinion that to obtain a satisfactory accurate test-piece, so as to avoid bending strain, the sample would have to be either ground or turned to a dead size.

Lack of uniformity in shear test results makes one consider what results other workers have obtained, and in the relation of tensile to shear one finds figures that are not in agreement, as the following will show:—

Fremont[3] states shear-test results equal tensile-test results.

Ronceray[4] states shear equals tensile.

Siegle[5]. $\frac{\text{Shear}}{\text{Tensile}}$ ratio 1.2 to 1.4 on grey irons. No relation with mottled or white irons, as the shear strength was very high and tensile tests on such material gives lower results.

Elliott[6]. $\frac{\text{Shear}}{\text{Tensile}}$ ratio 1.14 to 1.31.

Rother[7]. $\frac{\text{Shear}}{\text{Tensile}}$ ratio 0.75.

Audo[8]. $\frac{\text{Shear}}{\text{Tensile}}$ ratio 0.916 to 1.2.

Thomas[9]. $\frac{\text{Shear}}{\text{Tensile}}$ ratio 0.9. to 1.00.

Rudeloff.r[8] $\frac{\text{Shear}}{\text{Tensile}}$ 0.67 ratio when using a 0.79-in. dia. test-piece taken from a 1.2-in. dia. bar and 0.64 ratio when using a 0.59-in. dia. test-piece taken from a 1.2-in. dia. bar. The methods of obtaining test-pieces were different from other investigators.

English Workers[11] found on a $\frac{\text{Shear}}{\text{Tensile}}$ number of tests carried out that the ratio varied from 1.00 to 1.8.

After noting these results carried such serious differences, and also very widely different methods of obtaining test-pieces and correlating test results, the writer decided to carry out a series of tests to obtain further information on the subject. At the foundries the writer controls it is the practice to take daily tests on all

large castings made for electrical plant. Fig. 1 illustrates the type of castings made. The majority of these are made to specification and under the supervision of Inspectors of the leading consulting engineers of England (including British Admiralty), Australia, New Zealand, Japan, Russia, India, Holland, Spain, etc. The tests taken are from test-bars cast on the castings and broken off by the Customer's inspectors who brand the test bars.

These bars are cast 14 in. long by 1¼ in. thick; afterwards they are machined to 1 in. square for the transverse test. After being tested on 12-in. centres (the deflection is taken during this test) the broken half is machined to 0.564-in. dia. 2 in. gauge length for a tensile test. The other half is used for Brinell hardness, chemical analysis and microscopic tests. A second bar is held for any duplicate tests, if required.

For the daily routine test, over a period of six months, the tensile test-bars were machined to 0.5 in. dia. and the broken piece was used for the shear test, as only a piece 1 in. long was required. By this method the writer considered that variables are eliminated due to varying sections where the tensile and shear test specimens from which were taken.

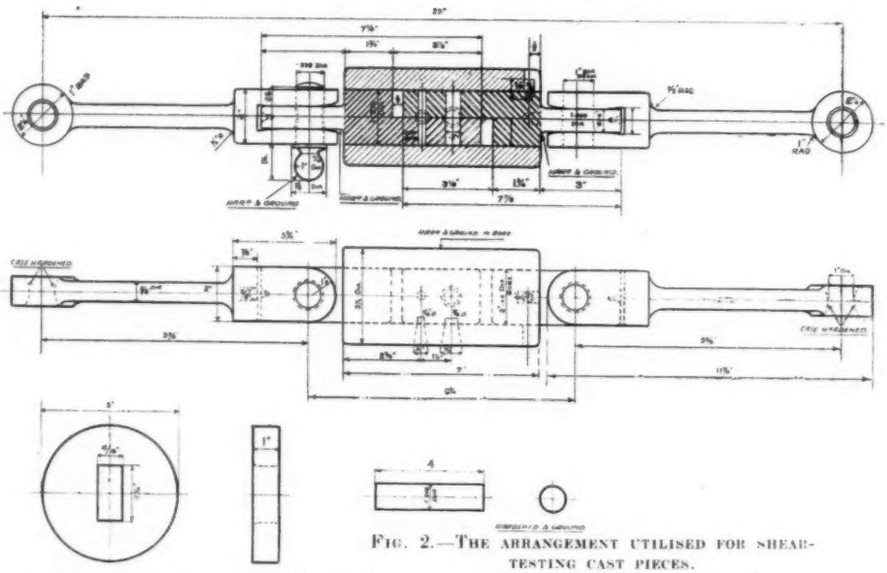

Fig. 2.—The arrangement utilised for shear-testing cast pieces.

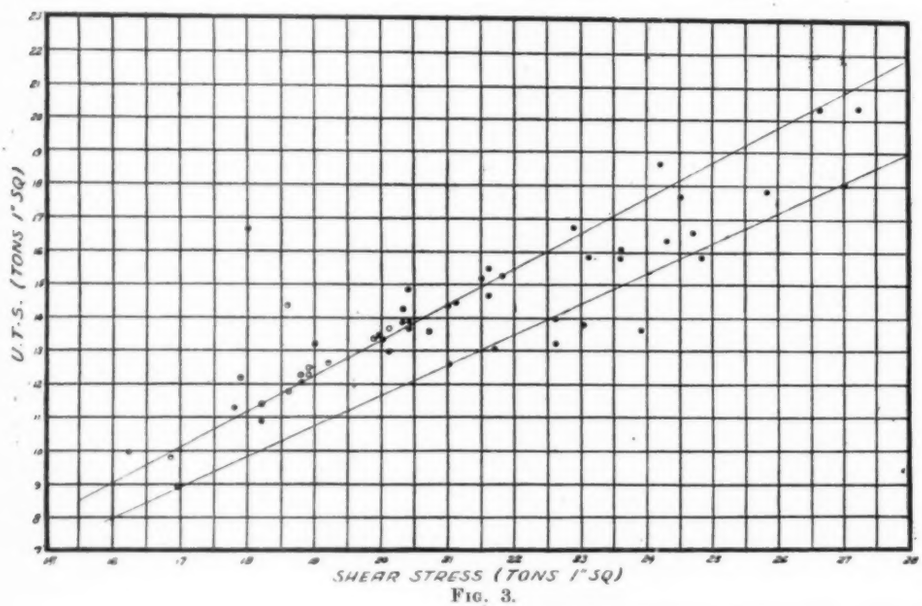


Fig. 3.

Fig. 2 shows the apparatus used for the single shear test, and as the sleeves were all ground to size and special self-aligning shackles were used in an ordinary testing machine all bending strain and deviation from a true shear was avoided.


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[10] Die Giesserei, August 14 and 21, 1926. 13594.
[11] Communicated Results.
[12] A.F.A. Proceedings, May 14, 1923.
[13] F.T.J. Proceedings, November 1922-23.
[14] F.T.J. Proceedings, November 1922-23.
[15] Stahl v. Eisen, August 3, 1922.
[16] I.B.F. Proceedings, 1926-27.


Fig. 3 shows tensile strength of over 50 tests plotted against shear tests. This curve is for a 0.5-in. dia. specimen obtained from the broken portion of the 0.5-in. dia. tensile test-piece.

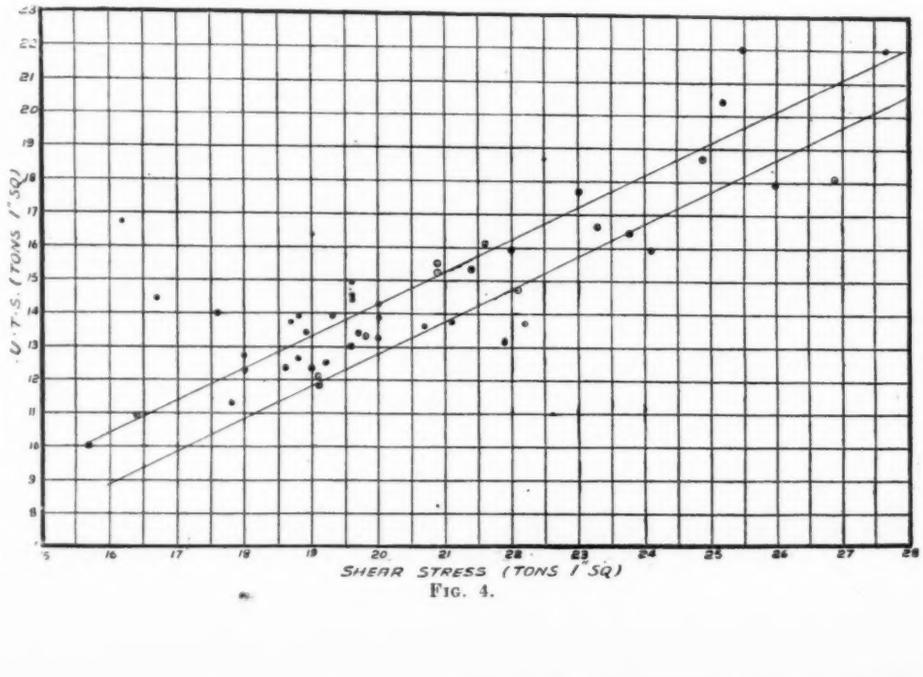


Fig. 4.

Fig. 4 shows a curve plotted on similar lines for the 0.22-in. dia. specimen. These test specimens were obtained from the remaining portion of the 0.5-in. dia. tensile test-piece.

*(To be continued.)*

## Applications for Trade Marks.

The following applications to register trade marks are extracted from the "Trade Marks Journal":—

Chanticleer device, with words "Silver Dawn" and "Best."—Galvanised flat steel sheets. A. G. Kidston & Company, Limited, 12 and 13, South Place, London, E.C.2.

"Spedex."—Non-ferrous metals. Barker & Allen, Limited, Spring Hill, Birmingham.

Device of two superimposed semi-circles.—Turbines and machinery for marine propulsion. The Parsons Marine Steam Turbine Company, Limited, Turbinia Works, Wallsend-on-Tyne.

"Pixie Brand," with device.—Metals. A. G. Kidston & Company, Limited, 12 and 13, South Place, London, E.C.2.

The Belgian Comptoir for the sale in Belgium of phosphoric and low-phosphorus foundry iron made by the members of the Franco-Belgian-Luxemburg triple convention has been set up as a Co-operative Society with registered offices at 206, Rue de la Loi, in Brussels.

# Cheaper and Better Cast Iron.*

### Vote of Thanks.

Mr. A. L. Key, in proposing a vote of thanks to the lecturer, said he had followed Mr. Young's contributions to the technical press, and he gathered from them an impression that the foundryman was regarded as a very inferior person who could make moulds, but so far as technical knowledge was concerned was completely out of it. It might be that impression was a mistaken one. Perhaps Mr. Young did not make his feelings or sentiments quite clear, or he (Mr. Key) had not analysed them correctly. On this occasion certainly it appeared that Mr. Young had altered his attitude considerably, and he had given what would be a very good lecture for those men who were conversant with the subject. Those who were not conversant would go away still feeling very much in the dark.

Mr. J. S. G. Primrose, in seconding the vote of thanks, remarked that the author had always held decided views upon foundry matters, and seemed to be the bearer of a kind of "fiery cross" whenever he discussed questions of scientific control. No doubt there would be others taking part in the discussion would like to know what was the name of the "burglar" mentioned by Mr. Young and whose footsteps were to be found in the graphite flakes present in cast iron.

### Manganese Sulphur Balance.

The Branch-President said during one of the great strikes, over a long period, he had to use much more scrap than had been thought advisable previously, and after the strike he continued to use an increased amount of scrap. Sulphur did not cause much trouble. He was not afraid of 0.18 per cent. of sulphur, and he had reached 0.2 without experiencing hardness. Hardness figures were taken every day, and he kept a close watch on the machine shop. But whenever the manganese content fell below 0.35—which occurred very rarely and almost accidentally—and with a silicon content of 2 per cent. he had a very hard casting. Yet one could have metal with a manganese content of 0.75 per cent. with the same silicon content, and get a nice machinable iron. The British Cast Iron Research Association had discovered some critical point in regard to the manganese balance in cast iron. He thought Mr. Young knew those critical manganese points in cast iron.

He agreed with Mr. Young that a carbon content of 3.2 or 3.3 per cent. was a workable and sensible content for cast irons. When using excessive scrap it was possible—he had proved it in practice—to maintain the iron uniform in silicon requirements by using a high silicious iron. Usually he obtained 3.2 or 3.3 per cent. of total carbon. They got a better result, a sounder casting, by using a silicious iron with the ordinary iron to arrive at the same silicon content.

It had always struck him as being rather amazing that sulphur should be so much feared. If scrap was used indefinitely the sulphur would not increase like a snowball, growing and growing until the iron contained say 50 per cent. of sulphur. At some point saturation was reached. He had known very few irons in which the sulphur went up to 0.2 per cent. According to generally understood metallurgical theories the sulphur content increases each time melted. This was not so, otherwise founders would be unable to use the shop returns—i.e. heads, runner gates, etc., which could be said to be in permanent use or in cycle.

Mr. Young said there had been no change in his attitude towards foundrymen. Years ago he stated that he thought the moulder had to exercise more skill than any other workman and had greater responsibility.

So far as sulphur-manganese balance is concerned he was not interested in any theoretical critical point, but preferred in practice to be on the safe side. He himself discovered there was a critical point and coined the term sulphur-manganese balance. The point varied with the iron used.

The Branch-President suggested that if one was using scrap containing, say, 2 per cent. silicon and desired to produce an iron with a greater silicon content than that, one would not obtain it by using more scrap. If one did so one would secure gradually less and less silicon. By having a high silicon iron one can maintain the silicon.

### Sulphur Saturation Point.

Mr. Young replied to Mr. Longden that iron containing about 3½ per cent. of silicon was a useful thing to add to scrap. Of course, it could be calculated out on paper. But one had to be careful about pig-iron. Lately he had found an expensive iron sold as containing 3.7 per cent. silicon which actually had only 1.8 per cent.

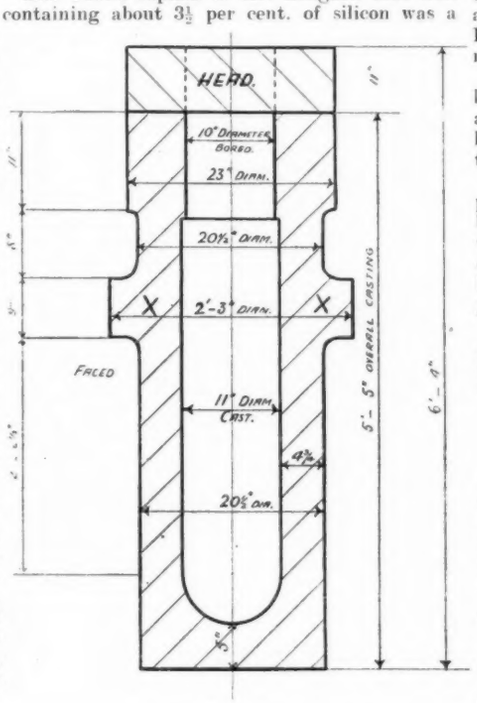


Fig. A.

It used to be suggested, if one went on remelting iron, the sulphur content became progressively higher. In actual practice it was impossible to go very high in sulphur unless there was some other abnormal circumstance.

From high sulphur-iron he made very good cylinder liners. A certain foundry tried to imitate this particular iron and made liners all of which cracked on test. To make high-sulphur iron was one thing; to make *good* high-sulphur iron was another. In normal practice if the manganese was correct one need not worry at all about sulphur. During the coal-strike some foundries using high-sulphur coke had trouble; others had not. It would be interesting to hear the experience of those who did have trouble.

### A Cylinder Problem.

Mr. Sutcliffe asked for Mr. Young's opinion about a sample of iron he produced. After being taken from the cupola and skimmed it was carried 30 yds., skimmed again, and cast. Quite a froth formed on it in the gate.

He also produced a drawing of a hydraulic cylinder, cast with a close iron. A previous old cylinder was cast without a belt, as a straight shaft, and it cracked. To prevent cracking, in the second cylinder a belt 4 in. in diameter was put on. He wanted an 18-in. head, but he could not have it, and it was cast with 11-in. head. The casting was spongy. They overcame the difficulty by racking it up. It weighed three tons. He wondered whether the belt caused trouble by drawing the casting down, and whether the trouble would have been avoided if the head had been 18 in. (see Fig. A).

A cupola temperature of 1,400 deg. C. had been spoken of. Of course steel was melted in the cupola, but it came down as cast iron. He observed that in the Foundry Trade Journal for the previous Thursday temperatures of from 1,500 deg. C. to 1,600 deg. C. were mentioned. He wondered whether ferro-chromium could be melted in a cupola at that temperature.

Mr. Young replied that he did not know what the sample was made from, nor the cupola practice, nor its final composition. He could not ascertain these points by looking at the fracture. He did not believe in making guesses in such matters.

Regarding the hydraulic cylinder, he recollected a case where a heavy belt occurred around a Diesel cylinder liner, which belt was machined loose afterwards, so that it could be slipped up to be caught by the top flange.

Judging by Mr. Sutcliffe's description of this particular casting he saw no necessity for the belt and thought it a mistake to have it. He would put from 18 to 24 in. of head on this casting. If anyone said "You must do it with less," the correct reply would be "Then do it yourself."

The head, when cut off, was refined pig-iron and valuable. It was better to have too much head than too little—the former could be remedied, the latter could not.

### Special Mixtures.

Mr. S. G. Smith said he shared Mr. Key's feeling that Mr. Young had modified his attitude towards the ordinary foundryman. It had been a most interesting lecture. Mr. Young dealt upon standard irons. He thought everyone would agree with Mr. Young that the foundryman's lot would be simplified a great deal if he had standard irons, especially if these could be supplied. Standard irons require some definition. But there must be some limitations. They could not have one standard iron for all classes of work. One standard iron might do for a certain class of work; for another class there must be another standard iron. Perhaps it may be possible they could have one for thin castings, another for medium-sized castings, a third for thick castings, but these could only be ordinary irons, and would not come under the category of special mixtures.

Mr. Young referred to the carbon content in pig-iron and that the manufacturers could not control it. That was quite true. For a good number of years he himself was in charge of foundries on the edge of pig beds, so he knew something about what happened there. Mr. Young referred to fracture, yet in a fracture of metal there were indications from which conclusions could be drawn to some extent, *i.e.*, whether the iron was very hard or very soft, very weak or very strong. That was not going very far, but one could not go farther, and there was no need to gaze very long for that. When a man had become acquainted with the irons made in a pig bed, he could tell pretty well what was to come, and judge roughly what its composition would be, according to the temperature of the furnace. Very often he (Mr. Smith) had to mix in the liquid form, and it was a custom of his to keep a large quantity of white iron in the form of thin pigs; and when he knew a very high silicon iron or a high carbon iron was coming, he added a quantity of these bars into the ladle. The temperature was

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* Discussion on Mr. Young's paper presented to the Lancashire Branch of the Institute of British Foundrymen, and published in our issue of March 21.

very high, and it melted very easily. It resulted in a medium ordinary iron. Amongst other things he had to use ferro-alloys to make special mixtures, but it would take too long to go into that. In his opinion, it was as necessary to standardise the cupola as to standardise the pig-irons or pig compositions. One slide showed sand in the cast metal. In his long experience he had never known that to occur unless the sand was pushed in wilfully.

With regard to the sketch of the hydraulic cylinder, he quite agreed with Mr. Young that the heavy part should not be put on. It weakened the cylinder more than it strengthened it; one reached into the soft part of the metal at this point, and it was likely to be porous, especially if there was any machining done on the outside. In making many of these hydraulic cylinders he had 3-ft. 6-in. head. That was with a heavy cylinder weighing about 12 to 14 tons; the head itself, with the runner basin, would weigh from 2 to 3 tons. But it was well worth while, as one had the satisfaction of having produced a sound and satisfactory casting. In the sketch shown by Mr. Sutcliffe, if there had been 18-in. or 2-ft. head, there would not have been porosity. The higher the head was lifted, the higher they lifted the porous part.

### High Graphitic Irons and Strength.

Mr. Young said that standard pig-iron would undoubtedly solve many problems. When the pig-iron was sometimes one thing and sometimes another, the foundryman did not know where he was.

He agreed that some information could be had from fracture, particularly if one knew something about the iron beforehand. That was what made it such a dangerous habit. For instance, if someone told him that one iron cost 78s., while another iron was something very good at 100s. a ton, he was likely to see in the fractures things which he would not have seen had he not been told the price. There were men making a great deal of money by selling to foundries wonderful pig-irons which in reality were quite ordinary ones. That sort of thing could not possibly succeed. Fracture-gazing was not as valuable as some people thought.

In one foundry he had to use only the pig-irons made by the firm, and cheap irons at that. He intended to make the high quality Diesel cast iron from these irons, and would undoubtedly succeed in doing so.

It was impossible to standardise cupolas without rebuilding them, and the average foundry was not given any money to spend. People would lay out money on machine shops but not on the foundry. Thereby they were making a great mistake, for the foundry is the hub of the whole works. He had been asked whether he thought the graphite was or was not graphite? His answer is: "Part of it is graphite, the rest is nothing at all." Under the microscope low-graphite irons often appeared similar to high-graphite irons.

Some years ago Mr. A. Logan read a significant paper on this point.

He thought the properties of Perlit, Emmel and other process irons turned upon this particular phenomenon, and he had not yet seen the explanation of it. He had asked the British Cast Iron Research Association to discover why iron containing high graphite was stronger in tensile than similar iron containing less graphite.

### Sand in Castings.

The presence of sand in metal depended to some extent upon the work which was being done. Few locomotive cylinders had not got sand occluded in the metal. In high-class Diesel work, using a very low-silicon iron, one cast at about as high a temperature as the cupola would give. There, again, sand might be occluded. A foundryman not doing work of that quality might never meet such cases.

Mr. Smith observed that his experience was with all kinds of jobs. He could understand it occurring as scab.

Mr. Young said he was not speaking of scab in the sense understood by the ordinary foundryman. The highest temperature he had observed in cupola metal in this country or abroad was 1,475 deg. C. It was very difficult to get that every time. The foundryman who got 1,400 every time was fortunate. The other week he himself got 1,550 deg. C., and promptly sent the pyrometer to be calibrated by the makers.

### High Sulphur Coke and Desulphurisation.

Mr. J. Jackson stated that he had a share of the trouble experienced with high-sulphur foreign coke. It was very noticeable, even with the first deliveries, how the air alongside the cupola was highly charged with sulphur fumes. Furnace workers complained of being gassed with the fumes from the metal as it came from the spout; the sulphur was so strong as almost to suffocate one. The front of the cupola got covered with a greenish deposit, a kind of sulphur film. The castings made at first from iron melted with this coke were generally too brittle; and the iron first run at the beginning of the blow gave white iron castings absolutely unmachinable.

He had the pleasure of having a conversation with Dr. Moldenke just previous to the Foundry Convention held in France. Dr. Moldenke then informed him of a German system of desulphurising molten iron by means of the use of soda ash. Naturally, when trouble came with the coke, this system was tried early: *i.e.*, placing the soda cake on the top of a bogie of metal, allowing a working period, then collecting the slag by lime and skimming off. He did his best to get this to work, though no success whatever was obtained.

However, success came with his next move, and good sound castings were made without any further trouble, such as chilled castings or excess sulphur in the iron. The sulphur fumes around the cupola, however, were always present during the whole time this particular coke was in use, that was until the Coal Strike was over.

To every blow, about half a bucketful of common soda ash was put in the coke bed, and the result was a thorough desulphurising effect on the coke took place through that. Quite a number of other works in the same district, which were using similar coke, closed down, due to this same trouble.

Another system he had heard of and tried out at another foundry was meeting with success. In this case, when they had blown down in the evening, they filled the cupola with coke, blew it until it became incandescent, then drew it down and watered it; a certain amount of sulphur was got rid of in that way. After this, of course, coke was charged in the ordinary way, though this, of course, was a very expensive method.

These were the only two instances he had come across where the coke was treated so that the foundries were able to produce good iron that was serviceable.

In regard to the comments on standard iron, he had been often impressed by the point which Mr. Young mentioned forcibly in the earlier part of his paper, *i.e.*, that English makers of iron took an analysis of every cast, yet this information was not passed on to the customer. Although the actual deliveries were quite in accord with the general analysis given, yet it would be very helpful to the foundrymen if the analysis of the cast could be forwarded with the delivery.

Mr. Young said he was much indebted to Mr. Jackson. Under ordinary conditions nothing other than limestone was required, and it was folly to spend money on fluxes.

At the present moment anyone who wanted standard pig-iron must pay a high price to the specialised manufacturer. It needed an independent person to work between the blast-furnace people and the founders, representing the interests of both parties and understanding their needs and their work.

### Inadequacy of Fracture.

Mr. George Hall (London) said as far as fracture in pig-iron was concerned he used to think, like most foundrymen, that when he broke a piece of pig he could tell what quality it was. A few weeks ago he broke some specially refined pig-iron bought at £7 per ton. Three parts across this fracture was absolutely white. Being dissatisfied with it he sent it to to the laboratory. The laboratory told him not to worry, as the pig was quite up to specification. It was used, and there was no question about it being satisfactory. Some of this pig-iron was used for a hydraulic cylinder 6 ft. long, 1 ft. 4 in. outside diameter, walls 3 in. thick, 5 in. thick at the base, with a 6-in. straight head at top of casting. The castings were tested and were definitely sound. He believed in heads, but there was a limit. When travelling in Germany he had seen castings made, some with large heads and some without heads, and when he came across a big head in a very large foundry he asked why it was put on, the reply was, "We do it for safety." He himself had been in the habit of using big heads, but gradually reduced them until with safety he had succeeded in getting down to 6 in., as in the case of the cylinder mentioned above, but is of the opinion that giving less head is taking a great risk.

The Branch-President said he would like to comment on Mr. Jackson's remarks about the use of high-sulphur coke and the first iron down. To his mind it was not the sulphur so much that caused trouble but the low temperature of melting; if there had been a correct ratio of air to the amount of coke used the trouble might have been righted. Really it was a question of rearranging the amount of coke or carbon to the blast or oxygen. They all knew that hard iron was also due to oxidation. Low-temperature melting caused oxidation, and was very likely the cause of the bad castings referred to.

## Papers for Presentation to the International Congress.

The following is the provisional list of Papers to be presented at the Congress:—

*American Exchange Paper.*—"Some Inter-Relationships in Grey Iron Metallurgy," by J. W. Bolton.

*French Exchange Paper.*—"Cast Iron Testing Methods," by M. Le Thomas.

"Steel Castings," by R. H. Greaves, D.Sc.

"The Influence of Chromium in Cast Iron," by J. W. Donaldson, D.Sc.

"Influence of Manganese in Cast Iron," by A. L. Norbury, D.Sc.

"The Practical Application of Nickel in Cast Iron," by A. B. Everest, Ph.D.

"Testing in Relation to the Design of Castings," by J. G. Pearce, M.Sc. (Eng.).

"Coal Dust as Applied to Moulding Sands," by B. Hird.

"Practical Points from the Metallurgy of Cast Bronzes," by H. C. Dews.

"Die Castings," by A. H. Munday.

"Influence of Sulphur in Cast Iron," by K. Gierdziejewski.

*Belgian Exchange Paper.*—Will deal with recruitment of workmen in Belgium during Armistice.

The Sociedad Anonima Altos Hornos de Vizcaza has recently put into operation three 70-ton open hearth furnaces, whilst the Cia. Siderurgica del Mediterraneo are installing two 80-ton furnaces at Segunta. The Bilbao plant has been supplied by a German firm of furnace designers.

# The Annealing of Cast Iron.

By H. H. Beeny, M.Met.

(*Continued from page* 231.)

The question of machinability is of great importance, and is frequently a deciding factor in the considering the advisability of annealing, and if so the nature of the treatment. Priester and Curran,[8] working on irons suitable for pistons, state that the machinability was improved six times by an annealing which destroyed the combined carbon. This statement will perhaps be generally admitted; in any case, in the works with which the author is associated reducing the combined carbon from 0.60 per cent. to a trace only in two medium silicon irons enabled the cutting speed to be increased three times, while the life of the tool in hours was lengthened by four times.

The thought of the piston above leads one naturally to think of the matter of wear. Diefenthaler and Sipp, leading up to the "Perlit" process, found that piston rings working in one cylinder gave the least wear when the combined carbon was such as to form a completely pearlitic matrix. Sturrock, in the discussion on Priester and Curran's Paper,[8] stated that his firm had discontinued the annealing of pistons owing to poor wear. Coyle[9] actually attempted laboratory wear tests. Dry friction under definite loads was used, and it was stated that such tests agreed with long period lubrication tests. He found that resistance to wear was a function of the Brinell hardness. Below 180 Brinell when the irons became definitely ferritic wear increased rapidly; a pearlitic matrix gave the best results.

All these statements and opinions tend to the one conclusion that, although annealing to remove the combined carbon improves the machinability, at the same time it much reduces the wearing properties. It is certainly the Author's opinion that *sand* castings which have to resist wear should not be annealed, or if this cannot be avoided on account of unmachinable chilled corners, then 850 deg. C. with air cooling is the least damaging temperature. This statement applies with less force the higher the silicon in the casting.

The elimination of chilled metal, which has been caused by the use of an overhard mixture, or follows from the use of denseners, frequently renders some kind of annealing treatment necessary. This question was studied by casting bars between 2-in. square cast-iron chills supported in moulding sand. Two opposite sides of the mould were formed by these chills and the other two by green sand. By varying the distance between the chills, and also width of the bars, the severity of chilling was controlled to suit the mixtures used.

The grades of metal, which are given in Table VI, are similar to those used before. The P/3 and S/3 bars were completely white through. The L/3 and H/3 bars were a little grey at the centre.

Table VI.—*Irons used to determine Temperatures required to remove Chill.*

| Percentage. | P/3 | L/3 | H/3 | S/3 |
|---|---|---|---|---|
| C.. .. .. | 3.16 | 3.21 | 3.27 | 3.40 |
| Si.. .. .. | 3.21 | 2.68 | 2.12 | 1.11 |
| Mn .. .. | 0.78 | 0.45 | 0.56 | 0.54 |
| S .. .. .. | 0.088 | 0.123 | 0.136 | 0.152 |
| P.. .. .. | 1.16 | 1.09 | 0.70 | 0.53 |

The chilled bars were ground smooth on one side and broken up into 2-in lengths. Sets of the most uniformly chilled pieces were selected. A set, which contained one piece from each grade, was first Brinelled with the small ball machine and a uniform area found; the pieces were then packed in a small mild steel box with a little charcoal at the bottom, and the lid luted on with ganister. Annealing treatment was carried out under pyrometric control and the hardness again determined, after allowing the box and its contents to cool freely in air. A separate set was used for each temperature, and the annealings were repeated until more or less stable hardness values were obtained. The progress was also checked by combined carbon determinations in certain cases.

Table VII.—*Brinell Hardness and Combined Carbon of White Chilled Metal after Annealing Treatments.*

| Temp. Deg. C. | Time. Hrs. | P/3 | | L/3 | | H/3 | | S/3 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Brinell hardness. | Combined carbon. Per cent. | Brinell hardness. | Combined carbon. Per cent. | Brinell hardness. | Combined carbon. Per cent. | Brinell hardness. | Combined carbon. Per cent. |
| 650 | 0 | 601 | — | 477 | — | 555 | — | 495 | — |
| ,, | 6 | 555 | — | 444 | — | 555 | — | 495 | — |
| 750 | 0 | 601 | — | 495 | — | 601 | — | 514 | — |
| ,, | 6 | 321 | — | 285 | — | 461 | — | 477 | — |
| 850 | 0 | 627 | — | 555 | — | 601 | — | 555 | — |
| ,, | 1 | 255 | — | 248 | — | 285 | — | 444 | — |
| ,, | 3 | 241 | — | 235 | — | 223 | — | 401 | — |
| ,, | 6 | 229 | 0.15 | 217 | 0.11 | 197 | 0.22 | 375 | 3.22 |
| ,, | 9 | 217 | 0.09 | 201 | 0.09 | 187 | 0.19 | 352 | 2.04 |
| 950 | 0 | 601 | — | 514 | — | 555 | — | 495 | — |
| ,, | 1 | 241 | — | 241 | — | 207 | — | 341 | — |
| ,, | 3 | 229 | — | 217 | — | 201 | — | 269 | — |
| ,, | 6 | 217 | 0.13 | 217 | 0.16 | 197 | 0.21 | 248 | 0.49 |
| ,, | 9 | 212 | 0·03 | 207 | 0.07 | 187 | 0.13 | 229 | 0.35 |

The results obtained are given in Table VII.

It will be seen that 650 deg. C. is quite useless for removing chill; 750 deg. C. is better, but is much too slow even with the highest silicon and therefore the most unstable metal. Three hours at 850 deg. C. is sufficient to produce metal of normal machinability out of all but the low silicon "S" grade; even 9 hrs. at this temperature failed to reduce the hardness of the latter to a satisfactory figure. Annealing at 950 deg. C. was much quicker. The reluctance of the "S" grade to anneal is due primarily to the low silicon, but also, no doubt is fostered as well by the high sulphur content, which, as is well known in connection with white heat annealing practice, tends to keep the carbon in the combined form.

A consideration of these results and those previously obtained on sand-cast bars makes plain the fact that annealing a casting at 750 deg. C. will very efficiently remove the pearlitic carbon, but will leave chilled corners or other local areas of free cementite largely unaffected. Such metal would naturally machine badly. For this reason, in the Author's opinion, the temperature attained during the commercial annealing of machining irons should not be less than 850 deg. C. This is not quite the minimum, but it is a temperature which allows some margin of safety without running up fuel and furnace costs, or causing damage to the metal due to overheating. For low silicon, high sulphur or other metal specially obstinate by reason of its composition, a higher temperature such as 950 deg. C. will give more speedy results.

Table VIII.—*Irons used for Comparative Tests on Sand and Chill Cast Bars.*

| Percentage. | P/4 | L/4 | H/4 |
|---|---|---|---|
| C .. .. .. .. | 3.23 | 3.25 | 3.27 |
| Si .. .. .. .. | 3.29 | 2.68 | 2.38 |
| Mn .. .. .. .. | 0.54 | 0.49 | 0.54 |
| S .. .. .. .. | 0.082 | 0.137 | 0.132 |
| P .. .. .. .. | 1.29 | 0.95 | 0.84 |

The appearance of the S/3 metal after 9 hrs. annealing at 950 deg. C. is given in Fig. 9. This metal was white through when cast, and the graphite has therefore precipitated in the nodular form. The structure is reminiscent of incompletely annealed black heart malleable, and has an appearance of strength, and even, one might think, ductility.

The temperatures required to efficiently anneal chilled metal have been determined, but so far the effects of chilling followed by annealing upon the mechanical qualities have not been touched upon. This is important, as annealed chill cast bars or castings have been produced commercially for many years. Frequently also heavy chills or denseners are placed in a mould in order to close the grain of a certain part, and this has an effect upon the mechanical properties.

Table IX.—*Comparative Tests on Sand and Chill Cast Bars.*

| Grade. | How cast. | Annealing temperature. Deg. C. | C.C. Per cent. | Transverse Test. | | | Tensile.† Tons per sq. in. | Modulus |
|---|---|---|---|---|---|---|---|---|
| | | | | Breaking load. Cwt. | Deflection. In. | Modulus of rupture. Tons per sq. in. | | Tensile. |
| P/4 | Sand | None | 0.39 | 10.5, 11.5 | 0.15 | 25.1 | 11.4 | 2.2 |
| ,, | ,, | 850+750 | Nil | 11, 11 | 0.18 | 25.1 | 11.7 | 2.1 |
| ,, | Chill | ,, | ,, | 16.8, 16.8 | 0.16 | 38.2 | 18.4, 19.6 | 2.0 |
| L/4 | Sand | None | 0.44 | 13.6, 13.8 | 0.17 | 31.3 | 14.3 | 2.2 |
| ,, | ,, | 850+750 | Nil | 13, 13 | 0.22 | 29.7 | 13.6 | 2.2 |
| ,, | Chill | ,, | ,, | 18.3, 19.6 | 0.22 | 43.2 | 18.2, 21.8 | 2.2 |
| H/4 | Sand | None | 6.59 | 15.5, 15.3 | 0.19 | 35.2 | 16.4 | 2.1 |
| ,, | ,, | 850+750 | Nil | 13.0, 13.1 | 0.20 | 29.9 | 14.6 | 2.1 |
| ,, | Chill | ,, | Tr. | 17.9, —* | 0.19 | 40.9 | 21.1, 20.6 | — |

* One bar badly flawed, the other slightly flawed.
† No bars gave measurable elongation.

Using one grade of iron containing 2.77 per cent. silicon, the subject was investigated by the late Mr. Broughall as long ago as 1918,[10] and he found very definite increases in strength in the annealed bars after casting in chills. The

present Author has carried out tests using the usual four grades of metal, and the microstructures have been studied. It is admitted that much more work remains to be done, but for the sake of one or two points of interest the results have been included.

The procedure was to cast two bars 1½ in. dia. by 14 in. long in chill moulds, and from the same ladle also to cast bars in green sand. The two chill-cast and two sand-cast bars were

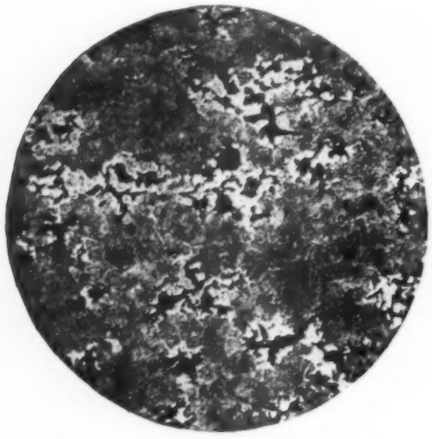

Fig. 9.—S/3 Metal annealed 9 hrs. at 950 deg. C. Etched 2 per cent. $HNO_3$ in Alcohol; × 100 dias.

Fig. 10.—L/4 Sand-cast Bar annealed. Etched 2 per cent. $HNO_3$ in Alcohol; × 100 dias.

Fig. 11.—L/4 Chill Cast and annealed. Etched 2 per cent. $HNO_3$ in Alcohol; × 100 dias.

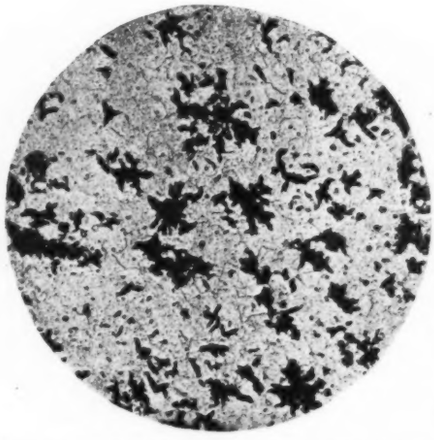

Fig. 12.—"S" Metal Chill Cast (White) and annealed. Etched 2 per cent. $HNO_3$ in Alcohol; × 100 dias.

annealed together so as to remove all combined carbon.

Table VIII gives the compositions of the grades used. As implied, experiments were also conducted on the low-silicon "S" metal, but the chilled bars were completely white through and axially unsound, due to the high shrinkage; the test results are not included. The H/3 chill bars were white halfway towards the centre, and were inclined to flaws in the outer chilled regions which affected the transverse tests.

The annealed bars, and also two untreated, were machined down to ¾ in. dia. as before. The tests are given in Table IX.

No combined carbon is present in these annealed bars, so that the strength differences are entirely due to differences in structure, size and distribution. We have already seen that machinery iron, such as the "P" and "L" grades, containing over 2.5 per cent. silicon when sand cast, does not alter in strength much with even the most complete annealing, and the maximum variation in transverse and tensile strength between the weakest and the strongest metal is less than 13 per cent. Such grades of metal answer well to accelerated cooling, however, and have the advantage that any chill formation is easily removed in the annealing.

Fig. 10 gives the structure of the L/4 metal as sand cast and annealed. All combined carbon has gone, leaving phosphide eutectic, ferrite and somewhat enlarged graphite flakes. The annealing treatment for this and the chill-cast bar was actually 3 hrs. at 850 deg. C., followed by 1 hr. at 750 deg. C. Fig. 11 is from the annealed chill-cast bar. The metal retained in the machined test bar had actually a uniform light-grey close fracture before annealing, and the micrograph is taken from this interior region. The dendritic structure is marked, and the graphite is distributed more as a fine dust than as flakes. In certain areas, when viewed at a high power, it has a distinctly eutectic appearance.

The change in structure from Fig. 10 to 11 represents an increase in transverse strength of 46 per cent. and in tensile strength of 47 per cent.

The detailed results from the S/4 metal have not been included owing to unsoundness in the test bars, as already stated, but Fig. 12 gives the structure of a chill-cast and annealed bar. This metal was white through when cast, and annealing, which was continued for 6 hrs. at 950 deg. C., followed by 3 hrs. at 750/770 deg. C., has precipitated the whole of the carbon in a more or less nodular form. The graphite precipitated in this way is infinitely coarser in form than that in Fig. 11, and even allowing for unsoundness the physical qualities were decidedly disappointing. The structure is very similar to that of black heart malleable, and it is rather surprising that no elongation was shown in the tensile test. A much better result is obtained by adjusting the composition so as to avoid deep chill. This makes for soundness, produces an extremely fine form of graphite, and such chill as is formed, being moderately high in silicon, is easily softened during the annealing process.

Taking, as previously with the first annealing tests, the fully annealed sand cast bar as standard, the increases in strength brought about by chill castings are as follow:—

| | Transverse test. Increase per cent. | Tensile test. Increase per cent. |
|---|---|---|
| P/4 ... | 53.0 ... | 62.0 |
| L/4 ... | 46.0 ... | 47.0 |
| H/4 ... | 38.0 (flaws) | 42.0 (sound) |

The severe conditions of chill casting have most favoured the high silicon metals in that they show the greatest *increase*. Taking the tensile bars, none of which were flawed, the actual strength increases with diminishing silicon, so that the H/4 metal shows an average tensile strength of practically 21.0 tons per sq. in., against 19 for the P/4 metal and 20 tons for the L/4 metal. This seems to indicate possibilities of even greater values for the lower silicons by increasing the diameter of the test bars. Time has not, unfortunately, allowed this to be followed up, but, bearing in mind the best values obtainable from sand-cast bars, enough has been done to show that the greatest development of strength is obtained by chill casting followed by annealing, and this can be done using comparatively cheap high-silicon mixtures. In America a similar process has been exploited for the production of small castings by machinery, and on a quantity basis, with beneficial results, and in less ambitious ways such metal has already proved of service at home.

The foregoing work has been carried out in the laboratory of Messrs. Alfred Herbert, Limited, Coventry, and the author desires to express his sincere appreciation to the management for permission to publish the results. He would also like to thank the laboratory staff for their assistance in the practical work, particularly to Mr. F. A. Neason for the analyses, and Mr. W. L. Smith for much of the micrographic and photographic work.

## SUMMARY.

The following are the main conclusions drawn from the Paper:—

(1) At annealing temperatures immediately below 800 deg. C. the pearlitic carbide is unstable and its destruction is merely a matter of time, but is the more rapid the higher the silicon in the iron.

(2) Massive carbide, as found in chilled metal, requires approximately 850 deg. C. to break it down completely in a two- or three-hour period. Temperatures below 800 deg. C. are quite useless to accomplish this, even with the silicon over

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3.0 per cent. Metal containing 1.11 per cent. of silicon with 0.152 per cent, sulphur required, however, 950 deg. C. for six hours. This is exceptional, and 850 deg. C. will suffice for all but the most obdurate irons.

(3) In general, the pearlitic carbon is stable at a temperature of over approximately 800 deg. C., and complete annealing cannot, therefore, be accomplished in this range of temperature alone. The statement must be qualified, in that the higher the silicon the less is the combined carbon retained, until with a silicon of 3.0 per cent. it becomes almost completely unstable. In medium- and low-silicon irons reheating above 800 deg. C. will reform a proportion of the carbide, even if previously completely decomposed, by annealing into iron plus graphite.

(4) The amount of carbide remaining stable or reformed increases with temperature from 800 up to at least 950 deg. C.

(5) The decomposition of carbide is rapid, in the range below 800 deg. C., so that the amount of carbide in the cold metal depends upon the rate of cooling through this range. Thus cooling in air blast retains considerably more carbide than cooling in still air.

(6) Pearlitic carbon has a definitely beneficial action on the transverse and tensile strength of cast iron. In general, the lower the silicon the greater the amount of combined carbon in the metal when cast and the stronger the metal, but when annealed the greater in consequence is the loss of strength. It follows that high-silicon irons are, in general, weak, and that they are but little affected in strength by any annealing treatment. The removal of combined carbon tends to reduce the strength of all irons to approximately the same low value. The general opinion that a completely pearlitic matrix gives the greatest strength is supported.

(7) The machinability is increased by loss of combined carbon. To obtain maximum machinability, castings should first be annealed at 850 deg. C. to remove possible chill and equalise the combined carbon in all parts, and then (actually or by very slow cooling) be maintained below 800 deg. C. to remove all combined carbon. This gives the minimum Brinell hardness.

(8) There is little doubt that in general the wearing quality is reduced with the combined carbon. This and strength considerations show that the *indiscriminate annealing of grey iron castings is thoroughly bad.*

(9) When all combined carbon has been removed by full annealing it is found that the Brinell hardness, that is the minimum Brinell hardness for any one iron, increases proportionately with the silicon-content.

(10) The Brinell hardness increases with the combined carbon in *any one metal,* but the hardening action of silicon is so marked that the Brinell hardness gives no idea of the combined carbon, irrespective of grade of metal, nor does it give the slightest indication of tensile or transverse strength.

(11) Supporting the generally accepted opinion, the tensile and transverse figures using machined bars show a constant relationship independent of composition, or whether chill or sand cast, annealed or unannealed. In general, the ratio of modulus of elasticity to tensile strength lies between 2.0 and 2.2 for machined transverse bars.

(12) Striking increases in strength with annealed chill-cast bars were obtained when the composition was such that deep chill formation was avoided. This makes for soundness, and the interior metal possesses a much finer form of graphite than that obtained by the annealing of completely white metal.

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M. Magdelenat, a vice-president of the Association Technique de Fonderie and a prominent French light-alloy foundry owner, has been promoted to be an officier of the Legion d'honneur. With others, who have been decorated with the office of Chevalier, he is being offered a complimentary banquet at the Hotel Lutetia, Paris, on Saturday week.

## Dear Copper.

From a Correspondent.

The copper market, which was consistently firm throughout the whole of last year, developed remarkable strength in December, and the Christmas holidays on both sides of the Atlantic interrupted a welter of buying orders from consumers in Europe and America. On several occasions during 1928 famine scares ran through the copper market and sent manufacturers flocking in a body to buy raw material for their trade, but it remained for the Chile earthquake late in November to put the final touch to the situation.

At first it was thought that the damage to mining properties was not serious, but within a few weeks news filtered through that the famous Braden Mine would be compelled to restrict production for a time and that shipments of rough copper might in consequence be seriously delayed. Britain's stock of such material at that time amounted to little more than 5,000 tons; merchants with commitments to sulphate manufacturers immediately took alarm, and there began a first-class scramble for warrants on the London Metal Exchange.

The serious illness of the King, coupled with the approach of the stocktaking period, had brought about something like stagnation in copper business during December, and merchants with copper on their hands had hedged on the London market, *i.e.*, sold for a date a month or so ahead to safeguard themselves against a fall in the quotation. The rush to buy prompt dates consequent upon the earthquake scare speedily revealed the existence of this bear account, and when the unfortunate "bears" realised their plight, brokers were inundated with instructions to cover in the open positions which were registering day by day an ever-increasing loss. All this created a pandemonium of buying, which continued into the early days of February and forced up prices on the London standard copper market to the highest seen since 1920. Incidentally, the would-be buyers found themselves very much "in the wilderness," for warrants were strongly held, and those seeking accommodation had to pay "through the nose" for it. So acute was the shortage of rough copper in the face of an insistent demand that bears were compelled to tender best select brands in lieu of blister.

The remarkable events taking place in London set the ball rolling in New York, and the copper producers were flooded with buying orders from manufacturers in the United States, who, in spite of the fact that the situation is now almost entirely under the thumb of Copper Exporters, Incorporated, still continue to base their buying policy on the tendency of prices in London. Successive advances carried the quotation in America to 18 cents, while the cost to British consumers is in the neighbourhood of £85 per ton, or 9d. per lb. Late in the year 1926 copper was quoted in America at about 12 cents per lb., so that in a space of little over two years the price has advanced by nearly 50 per cent. A remarkable achievement, which is pouring money into the pockets of copper mining groups throughout the world and bringing to shareholders the prospect of splendid dividends, for it is doubtful if the average cost of production much exceeds 10 cents per lb., and with many mines it is, of course, considerably less.

The total world production of copper is now well on the way to the second million, so that, in comparison with receipts about two years ago, the producers are now netting approximately an additional forty to fifty millions sterling per annum. This is being found for them by the consumers of the metal, and since the bulk of the copper used goes into long-term commissions, such as railway electrification, power plants, etc., ever-increasing capital is needed to finance such operations. Schemes of this nature are going ahead rapidly in America, and it is probably safe to say that, were the price of copper to go to £100 per ton, that country's enormous wealth would enable such developments to be carried on without a check. In the cable industry iron-cored aluminium cables are growing in favour, and with aluminium at only £95 per ton, it is certain that some inroads will be made on the popularity of the red metal, which is, of course, relatively so much heavier than its rival.

The comparatively low price at which copper has been quoted since the slump in 1921 has undoubtedly extended its popularity very greatly, and made it possible for manufacturers of copper goods to push their wares in competition with aluminium, steel and other metals, but, with strong copper quoted at £108, a comparison will no longer be favourable. Quite apart from the fact that makers of copper articles (and in a lesser degree of brass also) will be compelled to set aside considerably more capital to be locked up in stock and material in process, the ferrous trades will make headway at their expense and capture markets for the steel trade which have hitherto belonged to copper. Threepence per lb. on the price of sheets from which hollowware is made gives only a small advance in the cost of each article, but manufacturers are faced with the alternatives of cutting their profit to shreds, turning out an inferior article or losing the trade altogether.

More marked will be the effect of high-priced copper on the extension of electrical developments in Europe. Since the war, financial chaos and the impoverishment of all the belligerent countries have stood in the way of progress, and it is only now, after ten years of uphill struggling, that the Old World is finding it possible to put in hand many necessary schemes which were on foot when war broke out in 1914. Electricity marches in the van of civilisation's progress, and electricity means copper and still more copper if the forward movement is to be maintained. Europe's imports of refined copper alone amount to some half a million tons a year, or at any rate that total has been achieved under the stimulus of a low price, but very much more is required if electrical developments here are to match those being made in the great continent across the Atlantic. Europe is unfortunate in not being in a position at present to exploit such reserves of copper as lie within her boundaries, and since the formation of an American group controlling 90 per cent. of the world's output and eliminating merchant interests, she is doubly unfortunate in having little or no say in the price at which the metal shall be sold. Justification for the rise in the copper quotation is far to seek, but its effect will unfortunately be a reduction in the European consumption of a much-needed metal.

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**Carboloy.**—"Carboloy," a new machine-tool material composed of tungsten, carbide and cobalt, was recently put through a series of official tests at the Philadelphia Navy Yard. At the demonstration, which was ordered by the Navy's Bureau of Engineering, naval men and representativse of shipbuilding firms saw the new metal cut a 16-in. armour plate, cut a screw thread on blocks of plate glass and tool bakelite, porcelain and manganese steel. "Carboloy" is a product of the General Electric Company's laboratories, and has been in use in the company's own shops for more than two years. The cost of the work was reduced 25 per cent. it was said, and there was also a great saving in time. Mr. P. Petroff, manager of the marine division of the Carboloy Company, who had charge of the tests, declared that "Carboloy" was next to a diamond in hardness. It will scratch a natural sapphire, which is next below a diamond in the scale of hardness. Even though the tip of the new cutter should become heated to a bright red, a temperature that would be disastrous to any other material used for cutting, it will continue with its work as the material has no temper.

XUM

# Nickel-Chrome Alloy Iron.*

By W. R. Shimer.

### An Alloy-containing Pig-Iron.

The use of alloys in high-grade steel products, developed within the last 20 to 30 years, has attracted the grey iron industry who wanted to improve grey iron castings. To the writer's knowledge, the first alloys used in the manufacture of iron castings were nickel and chromium, which were obtained with the addition of a nickel-chromium bearing pig-iron containing these alloys naturally. This iron contains approximately 2 per cent. chromium, 1 per cent. nickel, a slight amount of vanadium, an appreciable percentage of titanium, and quite high total carbon. It is called Mayari pig-iron, having inherited its name from the Mayari province in Cuba.

This iron was first used in making wear-resisting castings such as pipe-balls, rolls, grinding-plates for feed-mills, liners for tube-mills and ball-mills, as well as sand-pump liners. It was very satisfactory for these purposes, due to the abrasion-resisting qualities of chromium and the

Fig. 1.

toughening properties of nickel. It was later found, also, by raising the silicon and by varying the percentage of this pig-iron in the cupola mix, that an excellent quality of grey iron casting was produced, and in recent years a large quantity of this iron has been, and is being, used in the manufacture of automobile cylinder-blocks and other important automobile castings.

It has been found that the introduction of alloys to the cupola can be more effectively accomplished by adding a pig-iron containing the alloys naturally than by attempting to add the alloys synthetically. In the latter case the pronounced improvement is not always obtained, and it is this fact that leads one to believe that the beneficial results attending the use of the nickel-chromium pig-iron are not obtained from nickel and chromium alone, but also from other deoxidisers in the iron, such as the high total carbon, titanium, and slight amount of vanadium. This nickel-chromium pig-iron seems to be a happy natural combination that actually produces the beneficial results desired.

### Effects of Natural Nickel-Chrome Content.

Another reason for crediting the natural combination is that a large tonnage of automobile cylinder-blocks is made with additions of nickel-chromium pig-iron as low as only 4 per cent., which means that only 0.04 per cent. nickel and 0.08 per cent. chromium have been added, these percentages being too small to indicate much added strength. It is a fact, however, that this 4 per cent. addition raises the hardness from an average of 180 Brinell to 200/220 and at the same time produces a casting which is more readily machinable.

In one of the large automobile plants, before they used this nickel-chromium bearing pig-iron, their machine shop complained when the castings ran over 180 Brinell hardness. Since the addition of small percentages of this nickel-chromium iron they aim regularly for 200/220 Brinell hardness, and production in the machine shop has increased. They, at times, machine cylinder-blocks as hard as 240 Brinell.

Moldenke explains that "the peculiar value of getting the nickel content directly from the ores in the pig-iron purchased, instead of adding it to the molten metal in the form of nickel metal, is the even distribution thus attained and not possible by direct addition." As to the effect of nickel and chromium in iron, Moldenke explains as follows:—

"Nickel, in addition to strengthening cast iron, also aids in separating out the graphite, or softening the metal. If nickel were the only special element added to cast iron by the use of pig-irons from Mayari ores, this property would be very noticeable. However, Mayari ores also contain chromium, and in quantity such that the pig-iron made shows approximately twice the chromium content as compared with that of nickel.

"Since chromium works in the opposite direction from nickel—holding carbon in the combined form—the net result is an increase in combined carbon, and stronger iron. Chromium, however, is known as a toughener of iron, and is desirable when present in not too great percentages. Hence, the combination of nickel-chromium as it exists in Mayari pig-iron gives a better grade of casting when Mayari is added to the mixture in proportions such that the hardening properties of chromium do not predominate in too great a measure over the softening effect of the nickel."

### Value of Cupola Additions.

The author has made melts in a 500-lb. experimental cupola and cast various shapes of test bars to determine not only tensile strength, but shrinkage, etc. These figures are not usually comparable with larger scale making of castings.

It has been found, however, from practical experience, the following benefits obtain from the use of this iron. For example, when from 20 to 25 per cent. of Mayari iron is added to iron, the mix containing 2 to 3 per cent. silicon, a casting is obtained that is heat resisting as compared with the ordinary grey iron. A 20 per cent. mixture produces a casting containing approximately 0.20 per cent. nickel and 0.40 per cent. chromium. For heavy, heat-resisting castings, with silicons ranging from 1 to 2 per cent., 25 per cent. of nickel-chromium pig-iron is added to the cupola mix.

It is used successfully in the manufacture of brake shoes, caustic-soda pots (in this case a 40 per cent. addition is made), chilled crusher-heads and plates, flour-mill rolls, chilled rolls, ammonia cylinders, gas-engine cylinders, locomotive cylinders, motor-cycle cylinders, alloy engine cylinders, diamond polishing wheels, drop-hammer dies, glass moulds, grate bars, heavy, medium and light machinery castings, piano plates, automobile pistons, automobile piston rings, automobile cylinder-blocks, sand-pump liners, white-iron castings, etc.

For wear-resisting castings, higher percentages of nickel-chromium pig-iron are used in low-silicon mixes. Grey iron castings are made with additions varying from as low as 4 per cent. up to 25 per cent.

The author has observed the use of this iron in many foundries for at least ten years, and finds, as compared with ordinary grey iron, it reduces shrinkages, makes a sounder, cleaner casting, close grained and readily machinable. The more readily machinable feature can be attributed to cleanliness, as a harder nickel-chrome casting machines more readily than a grey iron casting, which is much softer. The chromium has the effect of distributing the graphite into small, well-scattered flakes as compared with the large, weak flakes generally found in grey iron without these alloys.

During all the years that this nickel-chromium bearing iron has been manufactured, no attempt has been made to change the natural proportions of the alloys, which run approximately twice as much chromium as nickel. No occasion at any time has been encountered which required a change of these natural proportions.

### Ratio of Nickel Chromium Contents.

The author had occasion recently to investigate a chill for an autotype casting which chilled the type metal too quickly. The fracture of this casting was very open-grained, and a microscopic examination and chemical analysis disclosed that this casting contained unusually large weakening flakes of graphite, even though the casting was of low silicon content. Analysis showed: Total carbon, 3.37; graphitic carbon, 2.86; combined carbon, 0.51; manganese, 0.63; phosphorus, 0.348; sulphur, 0.102; silicon, 1.53; nickel, 0.34; and chromium, 0.07 per cent.

It would be expected, from this low total carbon and low silicon, that a close-grained casting would be obtained, having well-broken-up graphite graphite flakes. In spite of this, the flakes, as evidenced by Fig. 1, are very large, averaging at least 1½ in. long, and some as wide as ⅜ in. at 100 diameter. We can attribute this only to the well-known graphitising effect of the nickel which, as has been seen, is five times the chromium content, where as in the author's experience he finds the reverse to be true—*i.e.*, that the chromium should be twice the nickel content. This examination made it quite evident that it was the heat transference of this open-grained metal which caused the type metal to chill too quickly.

Mr. P. W. Blackwood presented a very interesting Paper before the Detroit Chapter of the American Society for Steel Treating in 1927 on "The Metallurgical Aspects of Cast Iron."

Under nickel he mentions that experiments on the influence of nickel on grey cast iron have been numerous. He quotes authorities such as Kup, Guillet, Thaler, Hatfield, Smalley, etc., who all find that nickel causes precipitation of graphite. Hatfield also expressed the opinion that the nickel at the same time acts as a softener, but is useful in no other direction. Blackwood also states:—"An investigation on the combined effect of chromium and nickel showed that certain relative proportions of these elements increased the tensile and transverse strengths, as well as the hardness and compressive strength, without diminishing the resistance to shock and deflection. It was shown that in the presence of chromium, nickel has nothing like such a powerful affect in precipitating graphite as when present alone."

The above investigations confirm the author's observations over a period of years of the beneficial effect of nickel and chromium in cast iron, obtained by the addition of certain percentages of this nickel-chromium bearing pig-iron.

* Paper read before the Western Metal Congress, January 14, 1929, at Los Angeles, California. The Author is Metallurgical Engineer of the Bethlehem Steel Company, Bethlehem, Pa.

# The Importance of Design and Setting of Large Kettles used for Refining and Low Melting-Point Alloys.*

By Harry C. Lancaster.†

Some forty years ago, when the Pattinson process for the concentration of silver in lead was in use, a kettle of 15 tons capacity was considered a large one. These iron kettles were almost universally cast in the shape of a half sphere and had no spouts, all the silver-lead being transferred by the use of large ladles and a small hand-crane. When the Parkes process supplanted the Pattinson process larger kettles were used, and the lead was transferred either by siphoning or pumping; or the kettles had spouts.

The author does not propose to deal with the quality of the cast iron used in these kettle castings, although this matter is undoubtedly important, and many suggestions have been made as to the best variety of cast iron to use for this purpose. Some foundries recommend the use of cold-blast pig-iron, the introduction of a percentage of good boiler plate scrap in the mixture, ageing of the castings, and other ideas. The author's experience suggests that large foundries which are accustomed to make big castings for the chemical industries are fully capable of producing sound castings; indeed, it is rare to get a faulty one. Other factors—apart from that of the quality of the iron used—which help to increase the life of the kettles are (1) the shape of the kettle itself and (2) the method of setting.

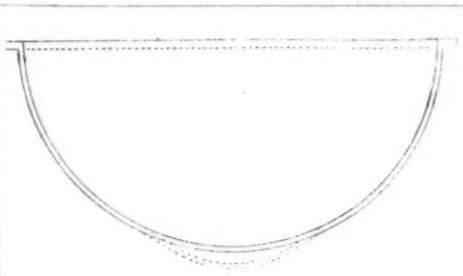

Fig. 1.

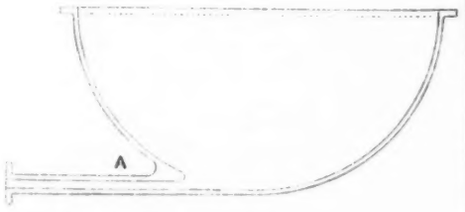


Fig. 2.

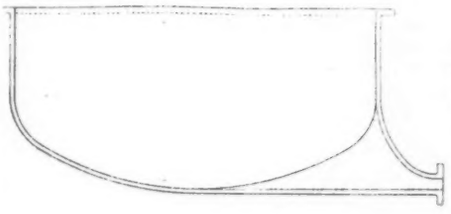

Fig. 3.

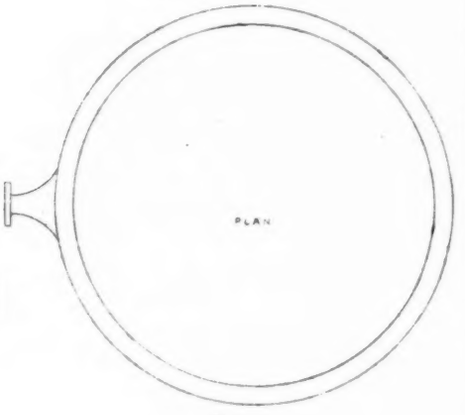


Fig. 4.

### Shape of the Kettle.

Most designers have considered that the casting should be a half sphere, and that this was however, measuring from 6 ft. to 8 ft. in dia., and calling for high-temperature treatment, the half-sphere casting has an inherent weakness in that the apex invariably becomes overheated, draws downwards—thus still further aggravating this inherent tendency—and becomes an additional source of weakness. Generally, the final result is a bad leakage at this point, as indicated in Fig. 1, where dotted lines show the bottom drawn down by over local heating. Now if a spout be added to the said half-sphere casting, another source of weakness is introduced (*see* Fig. 2, especially at the point *A*). Foundries have experienced difficulty in making the casting sound at this point, and the spout unfortunately joins the kettle at its weakest point, viz., where it receives the greatest heat; the author's experience with this design was disastrous.

By making the castings much flatter, under heavy but even heating they eventually assume the shape of approximately half a sphere. By altering the shape of the spout entirely, as indicated in Fig. 3 (section) and Fig. 4 (plan), the above-mentioned difficulties were overcome.

The author has encountered extraordinary diversities of opinion with regard to the thickness considered to be necessary in the case of quite small capacity kettles. Unfortunately many kettles are sold by weight, the inherent idea often appearing to be that if there is plenty of iron in a kettle it will add to its life. In one case a kettle holding less than 2 tons had a 5-in. bottom, and the supporting flange was $2\frac{1}{2}$ in. thick and 12 in. wide. The author's experience is that the thinner the casting, consistent with the weight and duty required, the longer the life.

Kettles of 8 ft. diam., required for high-temperature refining purposes, have only a $2\frac{1}{2}$-in. bottom tapering to $1\frac{3}{4}$ in. at the side, and a flange 2 in. thick by 3 in. wide. Similar kettles for lower temperatures, viz., about 500 deg. C., have a 2-in. bottom tapering to $1\frac{1}{2}$ in. at the side, with a flange $1\frac{1}{2}$ in. thick and $3\frac{1}{2}$ in. wide.

In the case of kettles used for refining operations, where the arsenate and antimoniate of lead attack the inside of the kettle, it is advisable to adopt the flange as shown in Fig. 5. This has a great cooling effect and thus prevents chemical attack. It is sometimes adopted to increase the capacity of a kettle, but is not good practice, as there is naturally a great loss of heating surface which has to be made good by the use of extra fuel.




Fig. 5.




Fig. 7

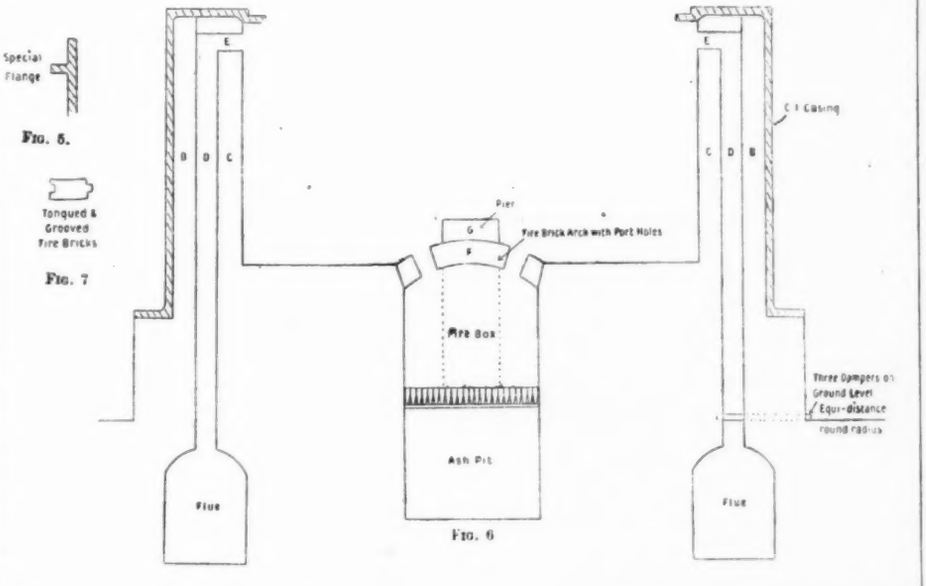


Fig. 6

### Setting the Kettle.

One of the essentials of long service from a kettle is even heating. This becomes increas-

* A Paper read before the Spring Meeting of the Institute of Metals.

† Director and Technical Adviser, Locke, Lancaster and W. W. and R. Johnson and Sons, Ltd., and the Associated Lead Manufacturers.

ingly difficult as the size of the kettle increases. It is important that a kettle, itself sometimes weighing 5 tons and containing 55 tons of metal, should have an adequate support and should be kept level. For this purpose it is advisable to have a cast-iron casing, cast either in two or four sections well bolted together—if possible outside, otherwise inside—as shown in Fig. 6. The cast-iron casing is lined with firebricks of the correct radius (*B*), these firebricks being tongued and grooved (Fig. 7). A similar firebrick wall (*C*) with 3-in. flue space (*D*) all round surrounds the kettle, and has occasional stretchers to keep the outer wall *in situ*, the latter having the pigeon-holes (*E*) equally spaced all round the top, just under the flange of the cast-iron casing. There are three dampers, communicating with the 3-in. flue space, connected with the downtake to the underground flue. These dampers must be carefully adjusted when first heating up a new kettle, so as to ensure even heating.

A firebrick arch (*F*) is built directly over the fireplace, with openings at the sides and ends only. This arch becomes incandescent and takes the excess heat from the actual bottom of the kettle, and tends to distribute this heat round the sides. Further, it prevents the rush of cold air impinging direct on a red-hot casting when opening the door whilst stoking or clinkering. In addition, the smoke is generally much better consumed and the heat is conserved. This arch, however, is better dispensed with should it be necessary both to heat up and cool off the contents of the kettle quickly. A supporting column—shown at *G*—in the case of 50-ton kettles is built within 2 in. of the bottom of the kettle when setting. It was found that to build this pier so that it came in contact with the bottom to start with was fatal—it tended to penetrate the bottom of the kettle. By building it just 2 in. below, the casting draws down that amount, and rests on the supporting pier without further apparent distortion or strain.

## Defective Steel Castings*

By G. E. Wells.

The designer makes a drawing of the casting which he requires, and the purchasing agent sends out an inquiry; the order is placed with a steel founder who sends in a defective casting. The question is at once raised: Why cannot a steel founder make any and every casting perfectly sound?

In the first place the manufacture of steel castings has not yet become an exact science. As a fact, a steel casting should, like a ship, be referred to as "she," since it displays a feminine fickleness which often leaves the steel founder in doubt what to do next. In its production there are few constants but many variables, and the methods which will produce good results one day will often fail on the morrow.

Generally speaking, the founder with the greatest experience will produce the biggest percentage of sound castings, but in any particular line the slightest change of material, method or design, may suddenly turn a sound product into one with a defect which will cause great trouble to the user.

In many cases the designer must be blamed, as in searching for the ideal he is apt to forget that practice always lags behind theory. Many of the founder's troubles, the expense of which he has to shoulder himself, should really have been worked out and solved on the drawing-board. Much closer co-operation between the designer of the casting and the man who has to make it is, therefore, essential.

Under to-day's abnormal conditions another factor in the production of bad castings is the buyer. Since the cessation of hostilities, the buyer has become more and more a specialist, and to-day, when steel foundries have a capacity far in excess of any demands made upon them, the buyer is Cock of the Roost.

### A Typical Buyer.

But for the fear of offending friends, the author would like to describe the buyer. In any event, it is safe to risk the statement that he has a dual personality. In business he is hard, unyielding, and out to buy at the lowest possible figure. In adopting this attitude he is doubtless carrying out what he considers his duty to the firm which employs him, but it is often questionable whether his action does not result in trouble and expense which could have been avoided by paying a little more in the first place.

A man drowning will clutch at a straw. Similarly, if a manufacturer sees his works without orders he will accept business at figures well below his minimum costs of production. He is driven to this in order to keep his men employed and his plant in working order, but when he executes the work in his plant, he makes it clear to everybody that it is necessary to reduce the inevitable losses as much as possible. The worst result of insistence on this point is that some over-zealous person may cut a price, and so, by treating a workman unfairly, kill any goodwill which exists. Another result is that a casting which should be made in a dry sand mould may be made in a green sand mould to save the cost of drying; or the size of feeding heads necessary may be reduced; or a number of other steps taken which are not good practice but are adopted in spite of the risk involved in order to bring the cost of production more into line with the selling price, which is too low.

In many instances this policy proves to be penny wise and pound foolish, as a casting made in this way is often rejected by the customer, so that the founder has to replace it at great loss to himself. Furthermore, the customer is seriously inconvenienced because of the delay caused by the waster casting, and has also to stand the loss of the machining which he may have carried out before the defect was discovered. In such circumstances it is obvious that the buyer would have been well advised to pay a little more when placing the order.

### Price Cutting.

The foregoing remarks have not been actuated by a desire to criticise the buyer. He is as human as the rest of us, especially when away from business. It is, however, considered that at business he too often makes the mistake of buying at the lowest price instead of using his judgment and placing his orders where he is likely to get service, *i.e.*, a combination of reasonable price, satisfactory delivery and sound material.

In some directions the author has every sympathy with the buyer, as those who control big organisations have, since the war, adopted new methods of selling their products. In the old days they used to work out a cost, add a certain profit, and refuse to sell below that figure. To-day they "negotiate" the orders. The word sounds so much better, and is more in keeping with the size of some of the businesses in this country. Negotiating means that the head of a concern meets a big buyer for a discussion. Ultimately, the former, who has been played off by the shrewd purchasing agent against a number of others, accepts the order at the best price he can get, quite irrespective of his costs of production. When he returns to his works, he sends for the buyer, explains the position, and promises him dismissal unless he can beat down all the suppliers of raw material, to the end that when the contract which he has foolishly taken is completed, a profit may be shown instead of a loss.

In many cases, English manufacturers hungry for work are shown large orders which are to be placed abroad unless they accept them at figures simply ruinous. The steel founder is human, and in these circumstances he often falls, with the result that he is bound to lose money. In his efforts to minimise his losses the same trouble occurs, *i.e.*, he cannot use all the methods within his knowledge which produce the best possible casting, and the purchaser is thereby put to additional expense.

It is a well-known fact that the standard of living of the workman in the Continental foundries is not comparable with that which the English workman has every right to expect. The author speaks on this question with emphasis because he is particularly conversant with conditions in the countries which are the greatest competitors.

### Wasters due to Commercial Conditions.

It is probable that one type of casting which has given more trouble than most others is that known as the wheel-blank which is purchased by the gear-cutter. The casting itself is difficult to make because of its design, as it has an inherent tendency to show defects at the junction of the arm with the rim. It is held that with certain exceptions all such castings should be rough-machined by the steel founder before delivery, but to do this work costs money, and as the casting is lighter than it would be if delivered in the rough, both these factors increase the cost per hundredweight.

The size and disposition of the feeding heads are of the utmost importance, and to get a sound casting it is often necessary to add extra metal in places from which it is difficult and costly to remove it. It seems logical, therefore, that as this expense is incurred by the founder in order to produce a sound casting, the purchaser should shoulder it. In actual fact he often refuses to do so, and the founder getting the order fails to make the necessary provision, with the result that the casting is either a "waster" or requires to be made good by electric welding.

The reader may be disappointed that it is not more technical, dealing with the actual troubles which crop up in the course of manufacture causing defects which mean much inconvenience to the purchaser of steel castings. It is a fact, however, that the number of things which can go wrong in the production of a steel casting is legion, and an article of so technical a nature would be most suitable for a foundrymen's society.

The author's object in writing is to call attention to the fact that bad castings may be produced for reasons other than the inexperience of the founder, and it is hoped that however much his views may be disagreed with, they may, at the same time, suggest that if improvement is to be effected, consideration must be given by the purchaser to the steel founder's point of view, and that the two interested parties must at least co-operate.

* Extracted from the "Edgar Allen News." The author is a director of Edgar Allen Company, Limited.

## A Novel Method of Cutting Runners.

The removal of risers and sink heads from castings which are still hot by means of a cutting blowpipe will, according to Oxy-Acetylene Tips, effect economy in this particular work in steel foundries. By shaking the casting from the mould as soon as it is safe, and rubbing away excess sand from the base of all the projections, cutting operations may be started immediately.

The temperature of the casting should be almost high enough to maintain the reactions continuously without preheating flames. This saves oxygen and acetylene and allows the operator to work more quickly, as he seldom loses the cut on hot metal.

The metal of the hot casting is in a semi-plastic condition and absorbs any differential stresses caused by the local heat of the cutting. This feature is of great importance in high carbon and alloy steel castings or metal in which an undue amount of slag particles is trapped. When such metals are cut cold with a flame, surface cracks often result.

# Coal Dust Rotary Furnace *versus* the Cupola for the Production of High-Quality Malleable Iron.*

By Dr. H. Kalpers, Berlin.

The cheapest process of melting cast iron has been generally recognised to be the cupola method, although the cupola must be regarded as the worst process, qualitatively considered, as cupola cast iron often depends upon factors which the founder is unable arbitrarily and systematically to influence. The physical and chemical properties of the coke, for instance, is subject to wide fluctuations which frequently affect the properties of the iron melted in quite unexpected fashion. Recent investigations have shown us that an iron having the same carbon, silicon, manganese, phosphorus and sulphur contents may exhibit quite different physical properties which are particularly pronounced when malleable cast iron is being annealed. The gases and oxides, in particular, which cupola iron always contains in varying quantities, have been found to be of considerable importance.

It is upon a knowledge of this fact that is based the process of Dr. Stotz (Düsseldorf-Lohausen) for manufacturing a high quality malleable iron in the cupola, and which consists in adding to the mixture what are termed "tempering packets," the metals of which, protected by the cement enveloping them, reach the furnace shaft above the layer of slag resting on the iron bath, and which pass over the cement and exert a powerful disoxidising effect.

In this particular process, the manganese content is kept at a ratio to the sulphur content which experience shows to be the best, and the carbon content is kept sufficiently low by adopting suitable precautions. In this way, an iron can be melted which, owing to the small amount of oxides and gases it contains, can be malleablised soft and tough with an annealing period of about 50 hours full heat at 950 deg. C., and whatever the thickness of wall.

It is obvious that, with this short period of annealing, decarburisation is only sufficiently effected where the thickness of the walls is not more than about 10 mm. ($\frac{7}{16}$ in.), and that the malleablisation of the interior of thicker castings cannot take place by decarburisation, but must be effected by converting the carbon, *i.e.*, transforming the iron-carbide into ferrite and temper carbon in accordance with the equation $Fe_3C=3\ Fe+C$. The natural internal fracture of castings of this kind will have a black heart due to the temper carbon precipitated. If an iron still contains undecomposed cementite it cannot exhibit sufficient toughness or machining qualities. To malleabilise a "thicker" section of this kind by annealing to remove the carbon, the iron must be annealed twice as long as in the first-mentioned process. The new process thus possesses considerable economic advantages, and it is to be expected that malleable iron foundries will adopt this method on an increasing scale for producing "black heart" castings with a view to reducing cost of production and improving the quality of their castings.

According to earlier experiments,† the average tensile strength of cupola malleable iron was about 21.57 to 24.11 tons-sq. in., with an elongation of 2 to 3 per cent.; while the comparatively low-total average of 24.68 tons-sq. in. tensile strength and 3.8 per cent. elongation on a measured length of $2\frac{3}{8}$ in. was obtained from the standard bars submitted by 26 different foundries melting in cupolas to the Kaiser Wilhelm Institute for Iron Research, Düsseldorf, in 1926, at the suggestion of the German Engineering Standards Committee.

In face of these earlier results, it should be pointed out that it is quite possible nowadays to melt a malleable iron in the cupola sufficient to ensure with safety the minimum figure of 24.11 tons-sq. in. tensile and 4 per cent. elongation laid down by the Standards Committee for high-quality white malleable iron.

A second table, more extensive in character, refers to Foundry B. Here the average tensile was 26.96 tons per sq. in., associated with 6.3 per cent. elongation.

It must be noted that the high strength figures shown above must be regarded as very good in the present state of development of cupola cast iron, and that it does not appear possible at present to melt in the cupola a malleable cast iron which can be guaranteed to attain the *minimum* elongation of 9 per cent. laid down by the Standards Committee for "high-quality black heart malleable cast iron." These high figures could only previously be attained with certainty by melting in the Siemens-Martin, reverberatory or crucible furnace, thus making the cost of production higher than where the cupola was used.

Considerable economic and technical progress has therefore been achieved by Messrs. J. D. Brackelsberg (Mispe, Westphalia), who have succeeded in developing a method of melting, using cheap coal-dust, which is able to satisfy the highest requirements. This process and the principal parts of the furnace are protected by patents filed in all civilised countries. The principle or object of the system is that, by experimenting and improving over a number of years, the patentees have succeeded in blowing the coal-dust into a slowly-revolving drum-furnace at such a high pressure that the greater bulk of the ash, which would otherwise have a disturbing effect, is deposited in the form of a fine sand in a spark-arrester chamber arranged behind the melting furnace.

The drum furnace (Fig. 1) consists of a cylindrical sheet-iron casing, resting horizontally on rollers, and rammed with a plastic refractory (quartz sand with about 95 per cent. $SiO_2$). For the present it is being marketed to hold 5 to 10 tons of iron. The inside length of the 5-ton furnace is 4 metres (13.1 ft.), and the inside diameter 1 metre (3.2 ft.). The pulverised fuel burner is in the middle of one of the ends; opposite it, in the middle of the other end, is the waste gas opening. On the side wall is a tapping hole with gutter, from which the liquid iron can be withdrawn by suitably rotating the furnace.

To charge the furnace, the charging door on the exhaust gas side is opened, and the iron thrown in by hand. In the newer furnaces, the drum rests on side bearings for this purpose, being tilted by a simple hoisting arrangement, when the charge, already prepared and contained on an elevated charging platform, is tipped into the furnace through a chute.

A further feature of the Brackelsberg furnace is that it slowly and continually revolves at a speed of one revolution per minute, *viz.*, three revolutions in one direction, then three revolutions in the other. This provides an indirect heating action, as the hot gases do not act on the iron bath in the form of a thin flame, their function being primarily to make the portion of the arch overhead white hot. Before, however, these portions can suffer damage by being melted off, the constant rotation of the furnace brings them under the charge, which they heat from underneath. The refractory furnace-lining is thus protected and attacked uniformly, so that it can last out 200 melts, and has even stood up to 260 melts. For purposes of comparison it should be stated that, where drum furnaces are oil-fired, they are only usually good for 80 to 100 melts with one lining. The continuous rotation of the Brackelsberg furnace properly degasifies and perfectly mixes the iron bath.

An additional advantage of the new furnace is that a specially designed powdered fuel conveyor worm enables drying of the coal to be dispensed with, so that coal-dust containing up to 10 per cent. moisture may be used without trouble. Nor is there any need to ensure that the coal used has a particularly low ash-content, as a fuel containing 12 to 14 per cent. of ash can be utilised without difficulty. In this way any cheap coal can be used, and this can be ground up in suitable mills in any foundry.

The consumption of such a comparatively low-grade coal amounts to 14 to 18 per cent. of the charge for melting malleable iron and overheating it to about 1,500 deg. C. For a 5-ton charge, and with the furnace coal, the time taken for melting a charge is $3\frac{1}{2}$ hours, and, with the furnace hot, about 3 hours. This, of course, assumes a pig-iron having a low carbon-content of 2.6 to 2.8 per cent., but there is no difficulty in superheating this to such an extent that even the smallest castings come out clean.

From tests carried out at the Kaiser Wilhelm Institute for Iron Research, Düsseldorf, the melting losses are comparatively very low, as the following comparison will show:—

| | C% | Si% | Mn% | S% | P% |
|---|---|---|---|---|---|
| Charge ... | 3.38 | 1.12 | 0.13 | 0.068 | 0.064 |
| Casting ... | 3.27 | 0.87 | 0.11 | 0.067 | 0.060 |

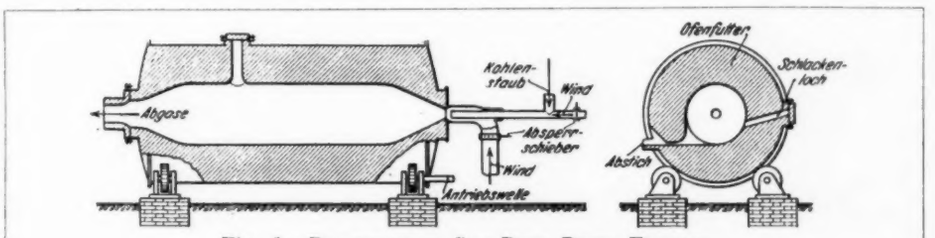


Fig. 1.—Brackelsberg Coal-Dust Drum Furnace.

Kohlenstaub = coal-dust; wind = air; absperrschieber = valve; abgase = waste gases; wind = blast; antriebswelle = driving-shaft; ofenfutter = furnace lining; abstich = tap hole; schlackenloch = slag hole.

The total ascertained loss was only 0.62 per cent., the percentage of iron converted into slag being only 0.15 per cent. Apart from the economic value of this low loss, the "neutral" atmosphere of the furnace gives special technical advantages; the material melted is extremely low in oxides and gases, and it gives very dense castings exhibiting the best physical properties.

To give an example: the average tensile strength of standard malleable iron test bars of $\frac{1}{2}$ in. diameter and a measured length of 60 mm. was found to be 24.11 tons per sq. in. with an elongation of 18 per cent., the charge consisting solely of malleable pig of the Duisberger Hupferhütte, 15 per cent. of cheap wrought iron scrap, and 50 per cent. of the foundry's own runners and risers. Using a pure iron charge, a very clean casting is also obtained of the following chemical composition:—C, 2.4 to

* Translated from "Giesserei-Zeltung."

† Cf. F. Wüst: "Mitteilungen aus der eisenherstellenden Industrie," Aachen, 1908, Vol. 2, p. 111.

2.6; Si, 0.5 to 0.6; Mn, 0.2 to 0.25; S, 0.02 to 0.04; and P, 0.04 to 0.05 per cent.

Comparing the operating costs of the Brackelsberg furnace with those of the cupola, we obtain the figures set out in Table I. According to these data, obtained from the foundry operations of Messrs. J. D. Brackelsberg (Mispe, Westphalia), the melting costs of the pulverised fuel furnace are lower than those of the cupola. Even though the price of coal were double the price assumed in the table, the melting costs would still be considerably below those for the cupola. This of course assumes a larger production consisting of three 5-ton melts a day. At a rough estimate, this gives an annual turnover of 3,750 tons = approx. 1,875 tons of good malleable iron.

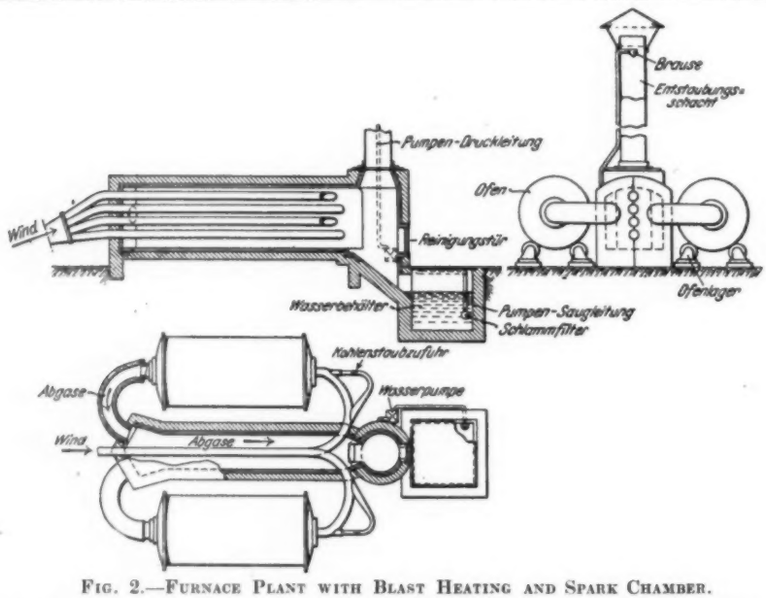


Fig. 2.—Furnace Plant with Blast Heating and Spark Chamber.

Wind = air; pumpendruckleit = pump delivery pipe; ofen = furnace; peinigungstür = door for cleaning; brause = spray; entstaubungsschacht = dust separator shaft; wasserbeh älter = water tank; pumpensaugleitung = pump suction pipe; schlammfilter = mud filter; ofenlager = furnace bearings; abgase = waste gases; kohlenstaubzufuhr = coal-dust delivery pipe; wasserpumpe = water pump.

Under German conditions this corresponds to the capacity of a fairly large malleable iron foundry. In smaller malleable iron foundries dealing with about 50 tons of castings a month = 600 tons a year, the melting costs will of course be higher, because only one melt can be made per day, so that the consumption of coal and also the general costs are higher. As the capital charges (10 per cent. of £1,000 = £100) must be distributed over a much smaller bulk of castings (to 1,200 tons of charge in the above example), the capital charges thus amount to 1.67s. per ton of charge.

It must be remembered of course that the provision of a coal-dust fired furnace of the type described enables grades of castings to be produced which seem to be impossible when working with the cupola, and this applies not only to malleable iron but also to high-quality grey cast-iron, and—with suitable arrangements for preheating the blast air—to steel castings. The coal-dust furnaces can be utilised alternately for melting grey cast-iron and malleable iron. As the coal-dust flame has a temperature of about 2,000 deg. C., in a neutral atmosphere, this furnace enables any kind of "improved iron" to be melted, as it is possible to work to any desired lower carbon content and any degree of super-heat owing to the low losses. The feature of high-quality grey-iron melted in the Brackelsberg furnace is its fineness of grain, density, and tensile strength of approx. 19.04 tons-sq. in.

Table I.—*Melting Costs for Cupola and Brackelsberg Furnaces.*

| | Cupola. Per ton of charge. | Brackelsberg. Per ton of charge. |
|---|---|---|
| | Shillings. | Shillings. |
| 15 per cent. of melting coke at 31s. per ton | 4.65 | — |
| 18 per cent. of coal dust at 12s. per ton | — | 2.16 |
| Materials for lighting the furnace .. .. | 0.50 | 0.20 |
| Miscellaneous small items .. .. | 3.50 | 2.50 |
| Lime and fluxes .. | 0.30 | 0.50 |
| Maintenance of furnace | 2.10 | 0.90 |
| Wages .. .. | 4.00 | 2.60 |
| Operating costs for melting .. .. | 15.05 | 8.86 |
| Depreciation, etc. .. | 0.67 | 0.53 |
| Melting costs for 1 ton charged .. .. | 15.72 | 9.39 |

Table II.—*Comparative Figures for Cupola and Brackelsberg Furnaces.*

| | Cupola furnace. | Brackelsberg furnace. |
|---|---|---|
| Capital cost for a throughput of up to 3,750 tons per annum | £1,250 | £1,000 |
| Melting losses, per cent. | 5 | 1 |
| Normal yield of good malleable iron, per cent. | 42 | 50 |
| Casting temp., deg. C. | 1,400–1,450 | 1,450–1,500 |
| Liquid iron .. .. | Rich in gases and oxides; carbon content difficult to adjust. | Low in gases and oxides; carbon content can be adjusted as desired. |
| Tensile strength, tons per sq. in. | 22.12 to 25.4 | 22.12 to 25.4 |
| Elongation, per cent... | 4 to 6 | 15 to 20 |

By using the waste heat of the furnace (approx. 1,600 deg. C.) for heating the blast, there is no trouble in producing a mild cast steel, as repeated experiments have shown. Such an arrangement of two drum furnaces with a common air-heater is shown in Fig. 2. As the blast is heated to 700 deg. C., the hot-blast pipes must be made of refractory material, and this slightly raises the cost of the plant. Since, however, existing grey and malleable iron foundries often wish to be in a position to produce steel castings occasionally, the Brackelsberg coal-dust furnace claims special attention in this connection.

In conclusion, then, the cupola now has a competitor in the shape of the coal-dust furnace, and one which appears to open up a fresh field for the production of quality cast-iron.

## Malleable Castings.

The London Junior Section of the Institute of British Foundrymen was given an interesting talk on "The Manufacture of Malleable Castings," by Mr. J. W. Gardom (Vice-President of London Branch), of Messrs. Bagshawe & Company, Dunstable, at a general meeting held at the offices of The Foundry Trade Journal, on March 22.

The lecturer gave a careful description of each of the processes used in the production of malleable iron castings, illustrating his remarks by means of lantern slides. He dealt particularly with the making of malleable-iron chains, pointing out that the same difficulties were experienced in the making of these as in the making of malleable castings, but with the addition of certain special peculiarities.

The first important point in making the mould for these chains was the choice of sand, care being taken in choosing a suitable one in order to get a good skin on the metal. Particular care had to be taken with the joint-lines.

It was important to keep to a definite suitable composition, and, for their particular work, they had found the following analysis to be one of the most satisfactory:—Total carbon, 3.2; silicon, 0.6; manganese, 0.13; sulphur, 0.2; and phosphorus, 0.1 per cent. He emphasised the necessity of keeping the mixture constant.

Passing on to the question of melting, the lecturer pointed out that in casting small links a very high temperature was essential. The necessity for keeping the carbon low presented a certain amount of difficulty in high-temperature work owing to the amount of coke. Very soft blast, comparatively slow melting, accurate weighing of the charges of iron and coke, and careful working of the cupola were essential.

It was difficult to keep the sulphur-content down in this type of iron, and it was almost impossible to maintain it lower than 0.1 to 0.15 per cent., or even 0.2 per cent. The first lot of metal passing through the cupola naturally absorbed the most sulphur. There was very little variation in the phosphorus-content and not much trouble with manganese. From experience one found the correct mixture for charging into the cupola to give out metal of the correct analysis. It was their practice to take three samples every day, one at the beginning, one at the middle, and one at the end of the melt, and have them analysed, which enabled them to ascertain that they were always obtaining standard material from their cupola. The lecturer then described the operation of annealing the chains, pointing out the difficulties of the process. In his opinion, annealing could not be successfully carried out without the use of a pyrometer. An enthusiastic discussion followed, after which a hearty vote of thanks was accorded to Mr. Gardom.

We are informed by the Wild-Barfield Electric Furnaces, Limited, that the American Hardening Furnace described on page 168 of our issue of February 28, is one of their furnaces, which are sold in America by the Hevi Duty Electric Company, Milwaukee.

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## Trade Talk.

The New Cransley Iron and Steel Company, Limited, Kettering, have restarted their two blast-furnaces.

It is reported that the South Durham Steel and Iron Company, Limited, contemplate re-starting their rolling mills at Stockton.

The address of the Expanded Metal Company, Limited, as from April 2, will be Burwood House, Caxton Street, London, S.W.1.

Three men were injured at the Cardiff tinplate works of the Melingriffith Company, Limited, on Tuesday, when a 20-ton flywheel burst.

Norwegian shipowners have placed an order for an ore-carrying vessel of 12,000 tons with Messrs. Palmers' Shipbuilding and Iron Company, Limited, Jarrow.

Considerable damage was done recently by an outbreak of fire at the Scotstoun Ironworks, Glasgow, of Messrs. Mechans, Limited, the pattern shop being destroyed.

The River Wear Commissioners have accepted the tender of Sir William Arrol & Company, Limited, amounting to £40,000, for the construction of a new staith at the Hudson South Dock.

A thousand metal workers employed in three automobile Vienna factories have gone on strike for the payment of wages lost to them by State and Church holidays, not including Sundays.

The works of Messrs. T. & C. Clark & Company, Limited, engineers and ironfounders, of Shakespeare Foundry, Horseley Fields, Wolverhampton, were considerably damaged by fire recently.

The Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders have decided to hold a joint summer meeting in Newcastle, from Tuesday to Thursday, July 2 to 4.

Messrs. David Colville & Sons, Limited, are engaged on a contract for the manufacture of special steel for the Spanish Navy. Rear-Admiral Xavier de Salas, of the Spanish Navy, visited the firm's Dalzell Works, Motherwell, recently.

Messrs. Cammell Laird & Company, Limited, Birkenhead, have delivered to the owners, Messrs. Elders & Fyffes, Limited, the steamer "Matina," which is intended for the West Indian, Central American, and United Kingdom fruit trade.

Sir J. H. MacLeod, Bt., the accountant appointed by the Scottish Manufactured Iron Trade Conciliation and Arbitration Board, has certified that the average net selling price in January and February was £10 7s. 6.58d. per ton. This means that there will be no change in the wages of the workmen.

The Admiralty have placed contracts for a flotilla leader with Messrs. Vickers-Armstrongs, Limited, Barrow-in-Furness, for two destroyers with Messrs. Palmers' Shipbuilding and Iron Company, Limited, Jarrow-on-Tyne, and for two destroyers with Messrs. Swan, Hunter & Wigham Richardson, Limited, Wallsend. A contract for machinery for the last two destroyers has been placed with the Wallsend Slipway and Engineering Company, Limited.

Messrs. Cox & Danks, Limited, who are engaged on the salvage of the sunken German Fleet at Scapa Flow, raised the 24,500-ton battleship "Kaiser" last week. Since they commenced operations at Scapa Flow, in 1924, Messrs. Cox & Danks, Limited, have raised 25 destroyers, representing a total tonnage of 22,600 tons; two battle-cruisers, the "Moltke," 23,000 tons, and "Seydlitz," 25,000 tons, and one battleship, the "Kaiser." The "Kaiser" will now be towed to the firm's depôt at Lyness, where she will lie alongside the "Seydlitz," and both ships will be prepared for their final voyage of 250 miles, in completely up-side-down positions, to Rosyth, where they will be dry-docked and afterwards dismantled and broken up.

The Central Electricity Board have placed the following further contracts, amounting to approximately £1,500,000:—South-East England Scheme: Contracts for 66-kv. and other transformers in the London area with the Hackbridge Electric Construction Company, Limited, and the British Electric Transformer Company, Limited. Central England: Contracts for 132-kv. transformers with the British Thomson-Houston Company, Limited, and the British Electric Transformer Company, Limited. North-West England: Contracts for 132-kv. transformers with the British Electric Transformer Company, Limited, the British Thomson-Houston Company, Limited, and Ferranti, Limited; contracts for 132-kv. outdoor switchgear with Messrs. Ferguson, Pailin, Limited, and the Metropolitan Vickers Electrical Company, Limited.

Messrs. Mavor & Coulson, Limited, Glasgow, have formed a subsidiary company, Mavor & Coulson (South Africa), Limited, to deal with their business in South Africa. The company will work in close co-operation with the Consolidated Pneumatic Tool Company, Limited, whose establishment in Johannesburg will also be the headquarters of Mavor & Coulson (South Africa), Limited. The aim of the company is to obtain and bring to this country orders for coal-cutters. There is a special sphere, they state, for their "Arcwaller" cutters, which are particularly adapted for cutting the wide "rooms" in the Transvaal coal seams, many of which are excessively hard. They intend also to develop their conveyor business in South Africa. Mr. G. M. Gullick, Messrs. Mavor & Coulson's mining director, has been appointed managing director of Mavor & Coulson (South Africa), Limited, and Mr. W. Ross, of the firm's conveyor department, will take up the position of resident chief engineer to the subsidiary company.

## Personal.

Sir Archibald Weigall has been appointed chairman of Allied Ironfounders, Limited, which has been registered as a public company with a capital of £3,000,000.

Engineer Vice-Admiral Sir Robert Dixon has been elected President of the Institute of Marine Engineers for the ensuing year, in succession to Sir Alan Anderson.

Mr. J. M. Bevan, of Neath, who has been appointed Sheriff of Carmarthenshire, is managing director of the Briton Ferry Steel Company, Limited, and is also a director of the Llanelly Steel Company (1907), Limited.

Mr. William Wilson, who for 27 years has been steelworks manager at the Skinningrove Steel and Iron Works of Messrs. Pease & Partners, Limited, has resigned in order to take up, it is understood, an appointment at Messrs. Dorman, Long & Company's Britannia Steelworks, Middlesbrough.

Mr. W. Simons, general manager of the Dowlais Works of Messrs. Guest, Keen & Nettlefolds, Limited, has been appointed Sheriff of Glamorgan. Mr. Simons is also managing director of Messrs. Guest, Keen & Piggotts, Limited, and the Orconera Iron Ore Company, Limited, and a director of the Cambrian Wagon Company, Limited.

## Reports and Dividends.

**Sir William Arrol & Company, Limited.**—Profit for 1928, £64,443; to special reserve fund, £40,000; carried forward, £21,391.

**P. & W. Maclellan, Limited.**—Interim dividend at the rate of 6 per cent. per annum on the cumulative preference shares.

**Stanton Ironworks Company, Limited.**—Interim dividend on the preference shares at the rate of 6 per cent. per annum, less tax.

**John Summers & Sons, Limited.**—Brought in, £180,833; dividend of 10 per cent. on the ordinary shares; carried forward, £183,210.

**Robey & Company, Limited.**—Profit, £3,508; debit brought in, £53,714; deficit carried forward after payment of debenture interest, £58,979.

**John Baker & Company (Rotherham) (1920), Limited.**—Net profit, £18,485; dividend of 5 per cent., less tax, on the ordinary shares, £9,000; carried forward, £13,468.

**J. Stone & Company, Limited.**—Net profit, £243,459; brought in, £128,388; preference dividend, £39,000; to reserve, £50,000; dividend of 20 per cent. on the ordinary shares; carried forward, £162,767.

**British Aluminium Company, Limited.**—Net profit, £441,383; brought in, £27,858; dividend 10 per cent., less tax; total allocations, £317,320, including £100,000 to reserve and £50,000 to depreciation; carried forward, £33,843.

**Bede Metal and Chemical Company, Limited.**—Profit, £30,862; brought in, £4,976; final dividend of 1s. 3d. per share, less tax, making 1s. 6d. per share for the year, £10,904; to general reserve, £10,000; to reserve for replacements, etc., £6,000; carried forward, £6,003.

**Imperial Chemical Industries, Limited.**—Profit, £5,488,243; to general reserve, £1,000,000; to income tax account, £275,540; final dividend on the ordinary shares of 5 per cent., making 8 per cent. for the year, and a dividend on the deferred shares of 1¾ per cent., both less tax; carried forward, £109,633.

## New Companies.

**Mavor & Coulson (South Africa), Limited,** 47, Broad Street, Mile End, Glasgow.—Capital £10,000 in £1 shares.

**W. & J. Forrester & Company, Limited,** 30, St. George Square, Glasgow.—Capital £5,000. Brass founders.

**Smarts Dinas Silica Brick Company, Limited.**—Capital £7,500. Directors: A. M. Jones, Bank House, Llanelly; and M. R. Richards.

**Aluminium Bronze Company, Limited,** 43, Cannon Street, Birmingham.—Capital £10,000. Directors: J. Hanson, Lieut.-Commander E. Richards, D. Richards, E. W. Perks and J. H. Harris.

**Allied Ironfounders, Limited,** Pinner's Hall, Austin Friars, London, E.C.—Capital £3,000,000 in £1 shares (1,500,000 preference and 1,500,000 ordinary), to acquire and hold the whole or any portion of the shares, debentures and other securities of Abbotts Foundry Company, Limited; R. W. Crosthwaite, Limited; James Clay (Wellington), Limited; Light Castings, Limited; the Forth and Clyde and Sunnyside Iron Companies, Limited; the Burton Foundry Company, Limited; the Falkirk Iron Company, Limited; the Sinclair Iron Company, Limited; and the Callendar Iron Company, Limited.

## Company News.

**Henry Bessemer & Company, Limited.**—Sir Walter Preston, M.P., presiding at the annual meeting of the company, held in Sheffield last week, said that from a trading point of view 1928 had been a most disappointing year. There appeared to be signs of improvement in trade in the country, but the tyre and axle trade was not one of the first to benefit, and it might be some months before the company reaped any appreciable advantage. There were too many firms in the tyre and axle trade.

**Crosthwaite Engineering and Furnace Company, Limited.**—At the annual meeting, held recently, it was decided to reduce the capital by writing off £32,644, representing capital which had been lost, or was not represented by available assets. In recommending the scheme, Mr. Ronald F. Adgie, who presided, said that the losses were largely the result of writing down old stocks, and that despite the general depression in the enginering trade, which had affected them in common with many other and larger engineering concerns, the company was still in possession of ample liquid assets to pay all creditors forthwith, and the whole of the assets were free from any charge.

## Contracts Open.

**Antwerp,** May 2.—Two steam or Diesel-motor tugs, for the Antwerp Municipality. The Department of Overseas Trade. (Reference A.X. 7644.)

**Antwerp,** May 6.—Two floating cranes, for the Direction de l'Outillage du Port, Antwerp. The Department of Overseas Trade. (Reference A.X. 7642.)

**Larne, Ireland,** April 11.—257 yds. of 4-in. cast-iron pipes, for the Larne Rural District Council. Mr. T. Nelson, clerk, Larne.

**Melbourne,** April 10.—Cast-steel wheel centres, for the Victorian Railways Commissioners. The Department of Overseas Trade. (Reference A.X. 7692.)

**Worthing,** April 13.—3,600 yds. of 7-in. socket and spigot cast-iron or spun-iron pipes and specials, for the Corporation. The Borough Water Engineer, Municipal Offices, Worthing.

## Obituary.

Mr. Fred Dyson, of Messrs. Dyson, Jones & Company, Limited, iron and steel merchants, Middlesbrough, died on March 21 in his 84th year.

The death has occurred, at the age of 84, of Mr. Alfred Earnshaw, of Kirkgate, Birstall. From the age of 23 to 50 he worked at the old Birstall Foundry of Messrs. Pearson & Spurr. After three years' working at Shipley he returned to the Birstall Foundry for a further six years. Then he went to Lancashire, but eventually returned again to the Birstall Foundry, and he was the man in charge of the last job completed there on closing down. On one occasion he walked to Liverpool, worked his passage to Ireland, and returned seven months later.

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# Iron and Steel Markets.

## Pig-Iron.

**MIDDLESBROUGH.**—So far as at present experienced, the holiday break has had little effect in checking active business in the Cleveland iron market, and booking over the April account, and even more advanced dates, continues in full swing. Beyond the mid-year, of course, Tees-side ironmasters now ask a premium of 1s. 6d. per ton on all contracts, and this has rather checked the ardour of speculative buyers for long-dated contracts. But the general industrial demand continues to expand, and, what is more, this expansion in home consumption synchronises with a growing call for Cleveland iron on the Continent. It would seem that the competitive power of the Cleveland iron trade is being restored both at home and abroad. With regard to the last-named markets, it is satisfactory to learn that returns of shipments from the Tees for the month just expired have more than doubled the totals for February, with exports still on an increasing scale. Subject to the proviso previously noted, Cleveland iron prices, both to home and foreign buyers, are unchanged as follow:—No. 1 foundry iron, 69s. 6d. per ton; No. 3 G.M.B., 67s.; No. 4 foundry, 66s.; No. 4 forge, 65s. 6d. per ton.

Heavy sales of East Coast hematite continue the order of the day, and only small quantities are still available for April disposal. In the hematite markets there are now no fixed quotations, and values vary according to quantity and date of delivery, but 74s. is a fair average figure for East Coast mixed numbers and 74s. 6d. for No. 1 quality, and on the North-West Coast about the same figure for Bessemer mixed numbers is still on offer.

**LANCASHIRE.**—Though demand for foundry pig in local markets has somewhat slowed down, due to holiday influences, there has been little or no fresh movement with regard to prices, but firmness in all directions is unmistakably in evidence. Derbyshire and Staffordshire brands are currently quoted for delivery to consumers in the Manchester district at 71s. and 73s. 6d. per ton respectively.

**THE MIDLANDS.**—With market operations practically suspended this week there are few changes in pig-iron conditions to report, with business generally on the quiet side. Quotations rule about as follow:—Derbyshire No. 3 72s. 6d.; North Staffs No. 3 75s., and Northants No. 3 69s., delivered stations in Birmingham and the Black Country. Derbyshire furnaces are offering No. 1 grade at 4s. extra, which was the agreed price, but Northants makers are holding out for 5s. extra.

**SCOTLAND.**—Conditions in the Scotch pig-iron markets remain unsatisfactory. Prices are unchanged on the basis of 72s. 6d. for No. 3 foundry f.o.t. furnaces, and although the demand is small, prices are firm, and a further rise is quite likely owing to the higher costs of production.

## Finished Iron.

At Birmingham the current inquiry for bar iron is certainly improving, and the actual demand for crown and the better grades is undoubtedly better. Owing to the increased cost of raw material there is a tendency for prices to stiffen, and good crown iron is now quoted at £9 15s. to £10, although in certain directions crown iron is offered at from £9 7s. 6d. to £9 12s. 6d. Nut and bolt iron, for which the demand is very meagre, is quoted at £8 17s. 6d. to £9 2s. 6d., while this class of iron from Belgium is on offer freely at £7 5s., and in certain cases at as low as £7 2s. 6d., delivered South Staffordshire works. Staffordshire marked bars are still quoted at £12, but it would not be surprising, in view of the higher costs of production, if the price were advanced in the near future.

## Steel.

At Sheffield this week a satisfactory state of business is reported in the steel market, with all prices quite firm. There is an active demand for basic billets, but acid qualities do not sell quite so readily. Wire rods continue a good market, although competition from the Continent is still fairly keen. Current prices: Basic billets, soft, £6 17s. 6d.; hard, £7 5s., £7 15s., and £8 15s.; acid billets, £8 15s. to £9; soft wire rods, £7 12s. 6d.; acid, £12. The demand for finished steel continues irregular, and while some good orders have been booked, the export demand continues somewhat disappointing. Lately, however, there have been indications that a revival in this direction may not be long delayed. In the tinplate market quotations are now a shade harder, and may be called:—Coke tins, 18s. 1½d. to 18s. 3d. basis, net cash, f.o.b. Wales.

## Scrap.

In the Cleveland area a brisk demand has recently developed for heavy cast iron, and as there is a great scarcity it looks likely that the foundries will have to pay higher prices. However, the best offers current were 62s. 6d. per ton for ordinary quality and 66s. per ton for machinery quality—figures which were not attractive to holders of this material. In the Midlands the improved demand for heavy cast-iron scrap, for use in the local foundries, has been maintained, and prices are firm at 70s. delivered for heavy machinery cast-iron scrap, broken into cupola sizes, and 57s. 6d. delivered for light cast-iron scrap. The Scottish markets for scrap material continue fairly active, machinery cast-iron scrap maintaining its price at 73s. 6d. to 75s. Ordinary cast iron to the same specification is quoted at 67s. 6d. Old cast-iron railway chairs are 70s. to 71s.; light cast-iron scrap, 65s. to 67s. 6d.; old cast-iron firebars are 63s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

## Metals.

**Copper.**—Though not maintaining the high range of values recorded recently, there has been no slump as yet in warrant copper prices, and business continues fairly brisk on consumptive account. With regard to supplies, the situation has in no way been relieved by increased quantities of electro, and, with the refineries already strained to their utmost capacity, any continuance of the present state of affairs is bound to result in a shortage of metal until the output can be further increased.

Official closing prices of standard copper have been as follow:—

*Cash*: Wednesday, £93 15s. to £93 17s. 6d.; Thursday, £94 to £94 5s.; Tuesday, £95 5s. to £95 7s. 6d.; Wednesday, £95 17s. 6d. to £95 18s. 9d.

*Three Months*: Wednesday, £95 2s. 6d. to £95 5s.; Thursday, £95 7s. 6d. to £95 10s.; Tuesday, £95 17s. 6d. to £96; Wednesday, £96 1s. 3d. to £96 3s. 9d.

**Tin.**—The position of the market for standard tin continues rather uncertain. Following the short period of firmness experienced the tone subsequently has been less confident, and as a result prices have tended to relapse. These fluctuations, however, are not very serious, and indicate no definite tendency. Consumption on the whole is fairly well maintained, but buyers are adopting a hesitant attitude, as the heavy supplies which are anticipated shortly would appear to be much in excess of the demand in the present dimensions.

Official closing prices of standard tin have been as under:—

*Cash*: Wednesday, £220 12s. 6d. to £220 17s. 6d.; Thursday, £220 5s. to £220 7s. 6d.; Tuesday, £219 10s. to £219 12s. 6d.; Wednesday, £219 10s. to £219 12s. 6d.

*Three Months*: Wednesday, £221 15s. to £222; Thursday, £221 10s. to £221 12s. 6d.; Tuesday, £220 7s. 6d. to £220 10s.; Wednesday, £220 7s. 6d. to £220 10s.

**Spelter.**—Irregularity has prevailed in the spelter market, but on the whole the tone is firm. Prices have relapsed recently as a result of supplies being in excess of requirements, but with the prospects of an increasing consumption in this country, and with the present active interest on the Continent, no radical movement is to be anticipated.

The following are the week's prices:—

*Ordinary*: Wednesday, £27 11s. 3d.; Thursday, £27 10s.; Tuesday, £27 11s. 3d.; Wednesday, £27 13s. 9d.

**Lead.**—After the recent remarkable rise experienced the price of lead has receded somewhat during the past week. On the whole, however, the position still continues firm, and, with American advices reporting strong conditions, demand from consumers, both in this country and on the Continent, has been active, but a great deal of speculative buying has been the chief cause of the rise, and at the moment consumers would appear well covered and are likely to hold off the market for the present.

The week's prices are appended:—

*Soft foreign (prompt)*: Wednesday, £26 3s. 9d.; Thursday, £26 6s. 3d.; Tuesday, £26 7s. 6d.; Wednesday, £26 13s. 9d.

## French Foundry Students' Annual Tour.

Following their usual custom, the students of the Paris Foundry High School made their annual round of works visits. Under the supervision of M. Ronceray, the director of the school, the students left Paris on March 22 and first inspected the works of M. Guillet & Sons at Duxerre. This firm manufactures woodworking machinery, and its importance, which was established in 1847, can be gathered by the fact that they invariably carry a stock of 5,000 machines ready for immediate delivery.

The next day was spent in visiting the famous Henri Paul foundry and the other shops of Messrs. Schneider, of Le Creusot. Shortly after its erection it was fully described in the columns of The Foundry Trade Journal. On Sunday the Sequin works at Lyons were inspected, whilst on Monday the electric steelworks of Ugine claimed their attention. In the afternoon the eight electric furnaces, having capacities ranging from 5 to 25 tons, installed at the Venthon works were examined. This installation undoubtedly stirred the imaginations of the students. These furnaces are making both ingots and tool steels.

Last year, when describing the corresponding tour, we thought fit to point out what an excellent system this was, and that it was worthy of emulation by similar organisations in Great Britain. We learnt from Professor Hanson that his students at Birmingham were accorded similar facilities, but we still feel that the system in general needs further expansion to embrace other universities and colleges catering for the foundry industry.

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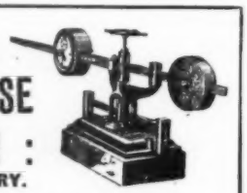
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Axle boxes, wheel centres, guides, brackets, and all spare parts for trucks.
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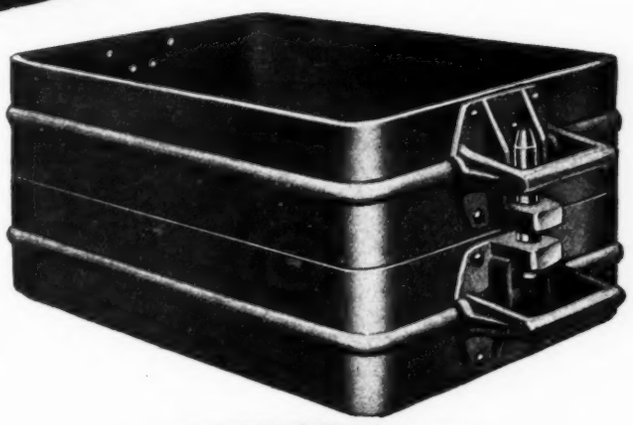

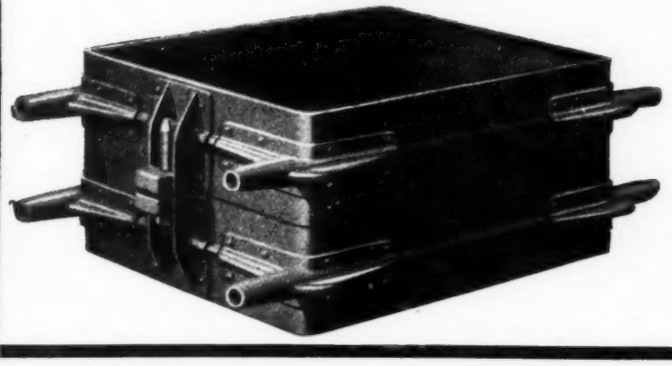

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## COPPER.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 95 | 17 | 6 |
| Three months | 96 | 1 | 3 |
| Electrolytic | 108 | 0 | 0 |
| Tough | 100 | 0 | 0 |
| Best selected | 100 | 0 | 0 |
| Sheets | 138 | 0 | 0 |
| India | 129 | 0 | 0 |
| Wire bars | 110 | 10 | 0 |
| Do. April | 110 | 10 | 0 |
| Do. May | 110 | 10 | 0 |
| Ingot bars | Nominal | | |
| H.C. wire rods | Nominal | | |
| Off. av. cash, March | 89 | 4 | 4½ |
| Do. 3 mths., March | 90 | 11 | 0 |
| Do., Sttlmnt., March | 89 | 3 | 6 |
| Do., Electro, March | 98 | 16 | 10½ |
| Do., B.S., March | 95 | 9 | 2 |
| Aver. spot price, copper, Mar. | 89 | 4 | 4½ |
| Do. wire bars, March | 99 | 6 | 7½ |
| Solid drawn tubes | | | 18½d. |
| Brazed tubes | | | 18½d. |
| Wire | | | 14½d. |

## BRASS.

| | |
|---|---|
| Solid drawn tubes | 15½d. |
| Brazed tubes | 17½d. |
| Rods, drawn | 13½d. |
| Rods, extd. or rlld. | 9d. |
| Sheets to 10 w.g. | 13½d. |
| Wire | 12½d. |
| Rolled metal | 12½d. |
| Yellow metal rods | 9d. |
| Do. 4 × 4 Squares | 10d. |
| Do. 4 × 3 Sheets | 10½d. |

## TIN.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 219 | 10 | 0 |
| Three months | 220 | 7 | 6 |
| English | 219 | 10 | 0 |
| Bars | 221 | 10 | 0 |
| Straits | 221 | 0 | 0 |
| Australian | 221 | 0 | 0 |
| Eastern | 223 | 0 | 0 |
| Banca | 224 | 0 | 0 |
| Off. av. cash, March | 220 | 17 | 4½ |
| Do., 3 mths., March | 221 | 15 | 5½ |
| Do., Sttlmt., March | 220 | 17 | 6 |
| Aver. spot, March | 220 | 17 | 4½ |

## SPELTER.

| | £ | s. | d. |
|---|---|---|---|
| Ordinary | 27 | 13 | 9 |
| Remelted | 26 | 10 | 0 |
| Hard | 22 | 0 | 0 |
| Electro 99.9 | 30 | 12 | 6 |
| English | 28 | 0 | 0 |
| India | 23 | 0 | 0 |
| Zinc dust | (Nom.) 39 | 0 | 0 |
| Zinc ashes | 9 | 0 | 0 |
| Off. aver., March | 27 | 3 | 5½ |
| Aver., spot, March | 27 | 1 | 0 |

## LEAD.

| | £ | s. | d. |
|---|---|---|---|
| Soft foreign ppt. | 26 | 13 | 9 |
| English | 28 | 0 | 0 |
| Off. average, March | 25 | 9 | 11¼ |
| Average spot, March | 25 | 8 | 2¼ |

## ZINC SHEETS, &c.

| | £ | s. | d. |
|---|---|---|---|
| Zinc sheets, English | 35 | 10 | 0 |
| Do. V.M. ex whf. | 35 | 2 | 6 |
| Rods | 46 | 0 | 0 |
| Boiler plates | 34 | 0 | 0 |
| Battery plates | 34 | 10 | 0 |

## ANTIMONY.

| | £ | s. | d. |
|---|---|---|---|
| Special brands, Eng. | 54 | 10 | 0 |
| Chinese | 38 | 10 | 0 |
| Crude | 33 | 10 | 0 |

## QUICKSILVER.

| | £ | s. | d. |
|---|---|---|---|
| Quicksilver | 22 | 3 | 9 |

## FERRO-ALLOYS AND STEEL-MAKING METALS.

| | £ | s. | d. |
|---|---|---|---|
| Ferro-silicon— | | | |
| 25% | 7 | 17 | 6 |
| 45/50% | 12 | 0 | 0 |
| 75% | 19 | 10 | 0 |
| Ferro-vanadium— | | | |
| 35/50% | ..13/9 lb. Va. | | |
| Ferro-molybdenum— | | | |
| 70/75% c. free | ..3/8 lb. Mo. | | |
| Ferro-titanium— | | | |
| 23/25% carbonless | 11d. lb. | | |
| Ferro-phosphorus, 20/25% | £16 | 10 | 0 |
| Ferro-tungsten— | | | |
| 80/85%, c. fr. | 2/0½ to 2/1 lb. | | |
| Tungsten metal powder— | | | |
| 98/99% | 2/3½ to 2/4 lb. | | |
| Ferro-chrome— | | | |
| 2/4% car. | £35 | 0 | 0 |
| 4/6% car. | £24 | 5 | 0 |
| 6/8% car. | £23 | 10 | 0 |
| 8/10% car. | £23 | 10 | 0 |
| Ferro-chrome— | | | |
| Max. 2% car. | £35 | 0 | 0 |
| Max. 1% car. | £37 | 2 | 6 |
| Max. 0·70% car. | £42 | 0 | 0 |
| 70% carbonless | 1/2 lb. | | |
| Nickel—99%, cubes or pellets | £175 | 0 | 0 |
| Ferro-cobalt | 9/4 lb. | | |
| Aluminium 98/99% | £95 | 0 | 0 |
| Metallic chromium— | | | |
| 96/98% | 2/6 lb. | | |
| Ferro-manganese (net)— | | | |
| 76/80% loose | £13 | 15 | 0 |
| 76/80% packed | £14 | 15 | 0 |
| 76/80%, export | £14 | 10 | 0 |
| Metallic manganese— | | | |
| 94/96%, carbonless | 1/6 lb. | | |

Per ton unless otherwise stated.

## HIGH-SPEED TOOL STEEL.

| | | | |
|---|---|---|---|
| Finished bars, 14% tungsten | £0 | 2 | 0 |
| Finshed bars, 18% tungsten | £0 | 2 | 9 |

Per lb. net, d/d buyers' works.

Extras—

| | |
|---|---|
| Rounds and squares, 3 in. and over | 4d. lb. |
| Rounds and squares, under ½ in. to ¼ in. | 3d. lb. |
| Do., under ¼ in. to 1/16 in. | 1/- lb. |
| Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. | 3d. lb. |
| Do., under ¼ in. × ¼ in. | 1/- lb. |
| Bevels of approved sizes and sections | 6d. lb. |

Bars cut to length, 10% extra

## SCRAP.

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| South Wales— | | | | | | | |
| Heavy steel | | | | | 3 | 17 | 6 |
| Bundled steel and shrngs. | 3 | 9 | 0 | to | 3 | 15 | 0 |
| Mixed iron and steel | | | | | 3 | 10 | 0 |
| Heavy cast iron | | | | | 3 | 5 | 6 |
| Good machinery for foundries | 3 | 5 | 0 | to | 3 | 7 | 6 |
| Cleveland— | | | | | | | |
| Heavy steel | | | | | 3 | 3 | 6 |
| Steel turnings | | | | | 2 | 14 | 6 |
| Cast iron borings | | | | | 2 | 10 | 0 |
| Heavy forge | | | | | 3 | 15 | 0 |
| W.I. piling scrap | | | | | 3 | 10 | 0 |
| Cast-iron scrap | 3 | 2 | 6 | to | 3 | 6 | 0 |
| Lancashire— | | | | | | | |
| Cast-iron scrap | 2 | 15 | 0 | to | 3 | 10 | 0 |
| Hvy. wrought | | | | | 3 | 12 | 6 |
| Steel turnings | | | | | 2 | 12 | 6 |
| Scotland— | | | | | | | |
| Heavy steel | | | | | 3 | 14 | 0 |
| Cast-iron borings | | | | | 2 | 16 | 6 |
| Wrought-iron piling | | | | | 3 | 12 | 6 |
| Heavy machinery | | | | | 3 | 13 | 6 |

London—Merchants' buying prices delivered yard.

| | £ | s. | d. |
|---|---|---|---|
| Copper (clean) | 70 | 0 | 0 |
| Brass | 45 | 0 | 0 |
| Lead (less usual draft) | 22 | 0 | 0 |
| Tea lead | 20 | 0 | 0 |
| Zinc | 19 | 0 | 0 |
| New aluminium cuttings | 67 | 0 | 0 |
| Braziery copper | 64 | 0 | 0 |
| Gunmetal | 60 | 0 | 0 |
| Hollow pewter | 160 | 0 | 0 |
| Shaped black pewter | 105 | 0 | 0 |

## PIG-IRON.

*(f.o.t. unless otherwise stated.)*

| | |
|---|---|
| N.E. Coast— | |
| Foundry No. 1 | 69/6 |
| Foundry No. 3 | 67/- |
| Foundry No. 4 | 66/- |
| Forge No. 4 | 65/6 |
| Hematite No. 1 | 74/6 |
| Hematite M/Nos. | 74/- |
| N.W. Coast— | |
| Hem. M/Nos. d/d Glas. | 81/6 |
| ,, d/d Birm. | 90/6 |
| Midlands— | |
| Staffs. common* | — |
| ,, No. 4 forge* | 71/- |
| ,, No. 3 fdry* | 75/- |
| Shrops. basic | — |
| ,, Cold blast, ord. | — |
| ,, ,, roll iron | — |
| Northants forge* | 65/- |
| ,, fdry. No. 3* | 69/- |
| Derbyshire forge | — |
| ,, fdry. No. 3 | — |
| ,, basic | — |

* d/d Black Country dist.

| | |
|---|---|
| Scotland— | |
| Foundry No. 1 | 75/- |
| ,, No. 3 | 72/6 |
| Hem. M/Nos. | 76/6 |
| Sheffield (d/d district)— | |
| Derby forge | 63/6 |
| ,, fdry. No. 3 | 67/6 |
| Lincs. forge | 67/6 |
| ,, fdry. No. 3 | 71/6 |
| E.C. hematite | 84/- |
| W.C. hematite | 86/- |
| Lincs. (at furnaces)— | |
| Forge No. 4 | — |
| Foundry No. 3 | — |
| Basic | — |
| Lancashire (d/d eq. Man.)— | |
| Derby forge | — |
| ,, fdry. No. 3 | 71/- |
| Northants foundry No. 3 | — |
| Dalzell, No.3(special) | 100/- to 102/6 |
| Summerlee, No. 3 | 90/- |
| Glengarnock, No. 3 | 90/- |
| Gartsherrie, No. 3 | 90/- |
| Monkland, No. 3 | 90/- |
| Shotts, No. 3 | 90/- |

## FINISHED IRON AND STEEL.

*Usual District deliveries for iron; delivered consumers' station for steel.*

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Iron— | | | | | | | |
| Bars (cr.) nom. | | | | | 10 | 5 | 0 |
| Nut and bolt iron | 8 | 17 | 6 | to | 9 | 0 | 0 |
| Hoops | | | | | 11 | 10 | 0 |
| Marked bars (Staffs.) f.o.t. | | | | | 12 | 0 | 0 |
| Gas strip | | | | | 11 | 10 | 0 |
| Bolts and nuts, ¾ in. × 4 in. | | | | | 15 | 5 | 0 |
| Steel— | | | | | | | |
| Ship plates | 8 | 7 | 6 | to | 8 | 12 | 6 |
| Boiler plts. | | | | | 10 | 10 | 0 |
| Chequer plts. | | | | | 10 | 12 | 6 |
| Angles | | | | | 7 | 17 | 6 |
| Tees | | | | | 8 | 17 | 6 |
| Joists | | | | | 7 | 17 | 6 |
| Rounds and squares, 3 in. to 5½ in. | | | | | 8 | 17 | 6 |
| Rounds under 3 in. to ¾ in. (Untested) | | | | | 7 | 15 | 0 |
| | | | | and | upwards | | |
| Flats, over 5 in. wide and up | | | | | 8 | 7 | 6 |
| Flats, 5 in. to 1½ in. | | | | | 7 | 17 | 6 |
| Rails, heavy | | | | | 8 | 10 | 0 |
| Fishplates | | | | | 12 | 10 | 0 |
| Hoops (Staffs.) | 10 | 10 | 0 | to | 11 | 0 | 0 |
| Black sheets, 24g. | 10 | 0 | 0 | to | 10 | 10 | 0 |
| Galv.cor.shts.,24g. | 13 | 10 | 0 | to | 13 | 15 | 0 |
| Galv. fencing wire 8g. plain | | | | | 11 | 10 | 0 |
| Billets, soft | 6 | 5 | 0 | to | 7 | 0 | 0 |
| Billets hard | 7 | 5 | 0 | to | 8 | 0 | 0 |
| Sheet bars | 6 | 2 | 6 | to | 6 | 6 | 6 |
| Tin bars | 6 | 2 | 6 | to | 6 | 6 | 6 |

## PHOSPHOR BRONZE.

| | Per lb. basis. |
|---|---|
| Strip | 1/6 |
| Sheet to 10 w.g. | 1/7 |
| Wire | 1/8½ |
| Rods | 1/7 |
| Tubes | 2/- |
| Castings | 1/6 |

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

## NICKEL SILVER, &c.

| | per lb. |
|---|---|
| Ingots for raising | 1/- to 1/6 |
| Rolled— | |
| To 9 in. wide | 1/6 to 2/- |
| To 12 in. wide | 1/6½ to 2/0½ |
| To 15 in. wide | 1/6½ to 2/0½ |
| To 18 in. wide | 1/7 to 2/1 |
| To 21 in. wide | 1/7½ to 2/1½ |
| To 25 in. wide | 1/8 to 2/2 |
| Ingots for spoons and forks | 1/- to 1/8½ |
| Ingots rolled to spoon size | 1/3 to 1/11½ |
| Wire round— | |
| 3/0 to 10 G. | 1/9½ to 2/4½ |

with extras according to gauge.

## AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

| | Dols. |
|---|---|
| No. 2X foundry, Phila. | 21.26 |
| No. 2 foundry, Valley | 18.00 |
| No. 2 foundry, Birm. | 15.50 |
| Basic | 19.26 |
| Bessemer | 20.79 |
| Malleable | 20.01 |
| Grey forge | 19.26 |
| Ferro-mang. 80% d/d | 105.00 |
| O.-h. rails, h'y at mill | 43.00 |
| Bess billets | 34.00 |
| O.-h. billets | 34.00 |
| O.-h. sheet bars | 35.00 |
| Wire rods | 42.00 |
| | Cents. |
| Iron bars, Phila. | 2.12 |
| Steel bars | 1.95 |
| Tank plates | 1.90 |
| Beams, etc. | 1.90 |
| Skelp, grooved steel | 1.90 |
| Skelp, sheared steel | 1.90 |
| Steel hoops | 2.20 |
| Sheets, black, No. 24 | 2.85 |
| Sheets, galv., No. 24 | 3.60 |
| Sheets, blue an'l'd, 9 and 10 | 2.10 |
| Wire nails | 2.65 |
| Plain wire | 2.50 |
| Barbed wire, galv. | 3.30 |
| Tinplates, 100 lb. box | $5.35 |

## COKE (at ovens).

| | |
|---|---|
| Welsh foundry | 25/- to 30/- |
| ,, furnace | 20/- to 25/- |
| Durham and North. | |
| ,, foundry | 20/- |
| ,, furnace | 17/- to 17/6 |
| Midlands, foundry | — |
| ,, furnace | 16/6 |

## TINPLATES.

f.o.b. Bristol Channel ports.

| | | | |
|---|---|---|---|
| I.C. Cokes | 20×14 | box | 18/1½ |
| ,, | 28×20 | ,, | 36/6 |
| ,, | 20×10 | ,, | 26/3 |
| ,, | 18¾×14 | ,, | 18/9 |
| C.W. | 20×14 | ,, | 15/- |
| ,, | 28×20 | ,, | 33/6 |
| ,, | 20×10 | ,, | 21/3 |
| ,, | 18¾×14 | ,, | 15/- |
| Terneplates | 28×20 | | 33/6 per box basis f.o.b. |

## SWEDISH CHARCOAL IRON & STEEL.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pig-iron | £6 | 0 | 0 | to | £7 | 10 | 0 |
| Bars, hammered, basis | £17 | 10 | 0 | to | £18 | 10 | 0 |
| Bars and nail-rods, rolled, basis | £15 | 15 | 0 | to | £16 | 15 | 0 |
| Blooms | £10 | 0 | 0 | to | £12 | 0 | 0 |
| Keg steel | £32 | 0 | 0 | to | £33 | 0 | 0 |
| Faggot steel | £20 | 0 | 0 | to | £24 | 0 | 0 |
| Bars and rods, dead soft, steel | £10 | 0 | 0 | to | £14 | 0 | 0 |

All per English ton, f.o.b. Gothenburg.

**TUBES AND FITTINGS.**

Up to and incl. 6 in.

| | *Tubes.* | *Fittings.* |
|---|---|---|
| Gas | 67½% | 50% |
| Water | 63½% | 45% |
| Steam | 60% | 40% |

W.I. 10% extra.

**Electrolytic Copper.**

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Mar. | 27 | 106 | 10 | 0 | dec. | 100/- |
| ,, | 28 | 110 | 0 | 0 | inc. | 70/- |
| April | 2 | 110 | 0 | 0 | No change | |
| ,, | 3 | 108 | 0 | 0 | dec. | 40/- |

**Tin** (English ingots).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Mar. | 27 | 220 | 15 | 0 | inc. | 2/6 |
| ,, | 28 | 220 | 15 | 0 | No change | |
| April | 2 | 219 | 10 | 0 | dec. | 25/- |
| ,, | 3 | 219 | 10 | 0 | No change | |

**Spelter** (ordinary).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Mar. | 27 | 27 | 11 | 3 | inc. | 1/3 |
| ,, | 28 | 27 | 10 | 0 | dec. | 1/3 |
| April | 2 | 27 | 11 | 3 | inc. | 1/3 |
| ,, | 3 | 27 | 13 | 9 | ,, | 2/6 |

**DAILY FLUCTUATIONS.**

**Standard Copper** (cash).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Mar. | 27 | 93 | 15 | 0 | dec. | 32/6 |
| ,, | 28 | 94 | 0 | 0 | inc. | 5/- |
| April | 2 | 95 | 5 | 0 | ,, | 25/- |
| ,, | 3 | 95 | 17 | 6 | ,, | 12/6 |

**Standard Tin** (cash).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Mar. | 27 | 220 | 12 | 6 | inc. | 12/6 |
| ,, | 28 | 220 | 5 | 0 | dec. | 7/6 |
| April | 2 | 219 | 10 | 0 | ,, | 15/- |
| ,, | 3 | 219 | 10 | 0 | No change | |

**Zinc Sheets** (English).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Mar. | 27 | 35 | 10 | 0 | dec. | 10/- |
| ,, | 28 | 35 | 10 | 0 | No change | |
| April | 2 | 35 | 10 | 0 | ,, | ,, |
| ,, | 3 | 35 | 10 | 0 | ,, | ,, |

**Lead** (English).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Mar. | 27 | 27 | 15 | 0 | dec. | 5/- |
| ,, | 28 | 27 | 15 | 0 | No change | |
| April | 2 | 27 | 15 | 0 | ,, | ,, |
| ,, | 3 | 28 | 0 | 0 | inc. | 5/- |

## AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

| Year | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Yearly average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| 1895 .. .. | 2 3 0 | 2 3 0 | 2 2 6 | 2 2 6 | 2 2 6 | 2 4 0 | 2 3 6 | 2 4 0 | 2 5 0 | 2 5 6 | 2 6 6 | 2 5 6 | 2 3 11½ |
| 1896 .. .. | 2 5 6 | 2 6 0 | 2 6 0 | 2 6 0 | 2 6 0 | 2 5 6 | 2 5 0 | 2 5 0 | 2 6 0 | 2 7 0 | 2 8 6 | 2 8 6 | 2 5 11½ |
| 1897 .. .. | 2 10 0 | 2 11 0 | 2 9 0 | 2 8 6 | 2 8 0 | 2 7 0 | 2 7 0 | 2 7 0 | 2 6 0 | 2 6 0 | 2 6 6 | 2 7 6 | 2 7 9½ |
| 1898 .. .. | 2 7 6 | 2 8 0 | 2 8 0 | 2 8 0 | 2 8 6 | 2 10 0 | 2 10 0 | 2 10 0 | 2 11 0 | 2 11 0 | 2 14 0 | 2 14 0 | 2 9 11 |
| 1899 .. .. | 2 13 0 | 2 14 0 | 2 14 0 | 2 14 0 | 3 0 0 | 3 2 0 | 3 13 0 | 3 16 6 | 3 15 0 | 3 16 6 | 3 16 6 | 4 0 0 | 3 6 2½ |
| 1900 .. .. | 4 0 0 | 4 0 0 | 4 0 0 | 4 1 6 | 4 1 0 | 3 18 0 | 3 13 6 | 3 12 6 | 3 11 0 | 3 11 0 | 3 9 6 | 3 8 0 | 3 13 6 |
| 1901 .. .. | 2 13 6 | 2 17 0 | 2 15 0 | 2 15 0 | 2 14 0 | 2 13 9 | 2 13 6 | 2 13 6 | 2 14 6 | 2 13 0 | 2 12 6 | 2 16 6 | 2 14 5½ |
| 1902 .. .. | 2 17 6 | 2 17 6 | 2 15 6 | 2 16 9 | 2 16 6 | 2 16 6 | 2 16 6 | 2 17 0 | 2 18 6 | 2 18 6 | 2 17 6 | 2 17 6 | 2 17 1½ |
| 1903 .. .. | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 |
| 1904 .. .. | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 |
| 1905 .. .. | 2 13 0 | 2 13 0 | 2 11 6 | 2 12 6 | 2 12 0 | 2 12 0 | 2 12 3 | 2 12 3 | 2 14 0 | 2 16 6 | 3 0 0 | 3 0 6 | 2 14 1 |
| 1906 .. .. | 3 2 0 | 3 5 0 | 3 3 0 | 3 0 6 | 2 17 0 | 2 18 6 | 2 18 0 | 2 16 6 | 2 19 0 | 3 0 6 | 3 1 6 | 3 7 0 | 3 0 8½ |
| 1907 .. .. | 3 7 0 | 3 7 0 | 3 5 0 | 3 2 0 | 3 4 0 | 3 8 0 | 3 6 0 | 3 5 0 | 3 4 0 | 3 2 6 | 3 1 0 | 2 18 6 | 3 4 2 |
| 1908 .. .. | 2 15 0 | 2 14 6 | 2 14 6 | 2 15 6 | 2 14 0 | 2 13 0 | 2 13 0 | 2 11 6 | 2 12 6 | 2 13 0 | 2 12 6 | 2 12 6 | 2 13 3½ |
| 1909 .. .. | 2 13 0 | 2 12 6 | 2 11 6 | 2 12 0 | 2 12 6 | 2 12 6 | 2 12 0 | 2 12 6 | 2 14 6 | 2 15 0 | 2 14 6 | 2 14 0 | 2 13 0½ |
| 1910 .. .. | 2 13 9 | 2 14 0 | 2 14 0 | 2 14 4 | 2 15 0 | 2 15 0 | 2 14 9 | 2 15 0 | 2 15 0 | 2 15 0 | 2 15 0 | 2 15 0 | 2 14 7½ |
| 1911 .. .. | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 14 6 | 2 15 0 | 2 15 0 | 2 15 8½ |
| 1912 .. .. | 2 17 4½ | 2 17 6 | 2 17 6 | 3 1 1½ | 3 2 6 | 3 3 9 | 3 6 3 | 3 7 6 | 3 10 10½ | 3 12 6 | 3 13 3½ | 3 14 6 | 3 5 4 |
| 1913 .. .. | 3 15 7 | 3 15 0 | 3 11 10½ | 3 11 4½ | 3 10 2½ | 3 6 10½ | 3 4 2½ | 3 2 9 | 3 1 9 | 3 1 0 | 2 19 3 | 2 17 2½ | 3 6 5 |
| 1914 .. .. | 2 17 2½ | 2 18 0 | 2 18 0 | 2 17 0 | 2 17 0 | 2 16 7½ | 2 16 0 | 3 2 10 | 3 1 0 | 2 19 9½ | 2 16 11½ | 2 18 1½ | 2 18 2 |
| 1915 .. .. | 3 1 2 | 3 3 11 | 3 5 9 | 3 18 8½ | 3 13 7 | 3 14 1 | 3 15 0 | 3 13 3 | 3 12 0½ | 3 11 1 | 3 14 0 | 4 3 3 | 3 12 2½ |
| 1916 .. .. | 4 4 6½ | 4 11 6 | 4 11 6½ | 4 7 6 | 4 7 6 | 4 7 6 | 4 10 0 | 4 12 10 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 8 6½ |
| 1917 .. .. | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 |
| 1918 .. .. | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 |
| 1919 .. .. | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 7 2 6 | 7 5 0 | 8 8 5 | 9 0 0 | 9 0 0 | 9 0 0 | 9 0 0 | 9 0 0 | 7 3 10 |
| 1920 .. .. | 9 13 9 | 10 0 0 | 10 5 3 | 10 15 3 | 11 10 0 | 12 2 6 | 12 5 0 | 13 1 3 | 14 7 6 | 14 5 0 | 14 5 0 | 14 5 0 | 12 12 1½ |
| 1921 .. .. | 12 11 8 | 10 8 9 | 9 2 6 | 8 2 0 | 8 0 0 | 8 0 0 | 8 0 0 | 8 1 8 | 7 4 0 | 6 7 6 | 5 7 6 | 4 16 10 | 8 0 2 |
| 1922 .. .. | 5 5 0 | 4 17 6 | 4 15 0 | 4 15 0 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 11 3 | 4 10 0 | 4 10 0 | 4 10 0 | 4 13 7½ |
| 1923 .. .. | 4 12 8½ | 5 0 2 | 6 2 6 | 6 8 7½ | 6 2 5 | 5 11 9 | 5 9 1½ | 5 4 0 | 5 0 0 | 5 0 9 | 5 0 7 | 5 2 9 | 5 7 11½ |
| 1924 .. .. | 5 3 0 | 5 3 0 | 5 3 0 | 5 3 0 | 5 2 10 | 5 1 3 | 4 17 11 | 4 15 6 | 4 13 6 | 4 10 1½ | 4 10 3 | 4 10 3 | 4 17 9½ |
| 1925 .. .. | 4 10 0 | 4 9 0 | 4 6 9 | 4 5 2½ | 4 3 0 | 4 0 1½ | 4 17 1½ | 3 15 7½ | 3 14 3½ | 3 13 4½ | 3 13 4½ | 3 13 2½ | 4 1 5 |
| 1926 .. .. | 3 14 9 | 3 15 3 | 3 15 6 | 3 15 3½ | 3 17 6 | 4 5 9 | 4 16 9 | * | * | * | * | 4 12 6 | 4 0 1½ |
| 1927 .. .. | 4 13 9½ | 4 13 3 | 4 11 1½ | 4 9 4½ | 4 6 1½ | 3 19 1½ | 3 16 1½ | 3 15 6 | 3 13 4½ | 3 13 4½ | 3 14 0 | 3 13 6½ | 4 1 6½ |
| 1928 .. .. | 3 13 2½ | 3 12 3½ | 3 12 3 | 3 12 3 | 3 11 6 | 3 10 0 | 3 8 3 | 3 7 8½ | 3 7 6 | 3 7 9½ | 3 8 3 | 3 7 6 | 3 9 10½ |
| 1929 .. .. | 3 8 3½ | 3 10 4½ | 3 10 10½ | — | — | — | — | — | — | — | — | — | — |

* No prices available during strike period.


# WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

# PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

# NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

# WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

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***(A remittance should accompany instructions.)***

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FOUNDRY MANAGER seeks engagement; 15 years' experience, possessing wide knowledge manufacture high-grade castings for all engineering purposes (especially Diesel); well versed machine moulding and modern foundry methods for quality production; accustomed drawings, estimating, and capable taking full charge all departments; first-class technical training; best references; willing invest small capital. — Box 174, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

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**SHEFFIELD.**
145,000 Sq. Ft. of SHOPPING,
Compact and Convenient.
**SIDING CONNECTIONS**
with L.M. & S. and L. & N.E. Rlys.
**WELL-BUILT & COMMODIOUS OFFICES**
Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

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ALBION WORKS, SHEFFIELD.

A TRAFFORD PARK BARGAIN.—Modern Foundry with own railway sidings, excellent warehouse, packing room and fine offices, centrally heated, for SALE. Premises are all one storey and easily adaptable for other trades. Cost £20,000 in 1921. For a quick sale, owners will take £2,000.—F. S. Airey, Entwistle & Company, 10, Norfolk Street, Manchester.

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SAND MIXERS.—New and second-hand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

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No. 60 "HEALD" Internal Grinding Machine, with planetary head.

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